MECHANICAL ENGINEERING

September 1942

A.S.M.E. FALL MEETING—ROCHESTER, N.Y.—OCTOBER 12-14, 1942

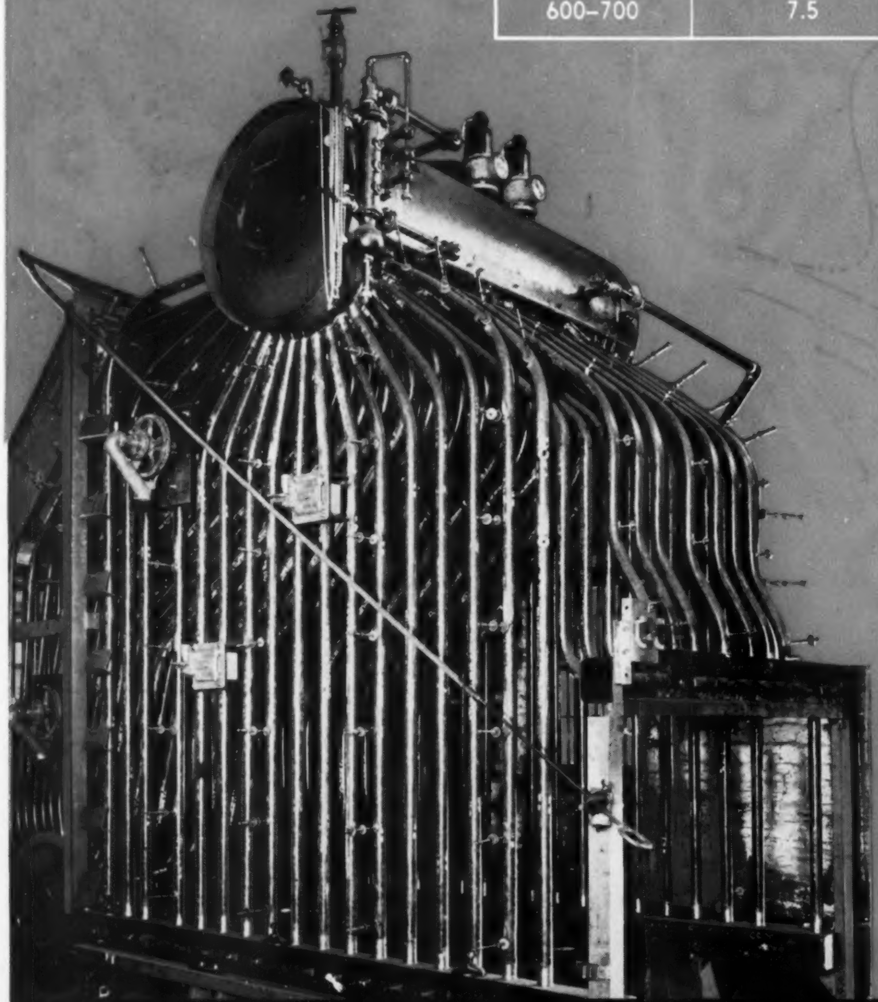
B&W INTEGRAL-FURNACE BOILER

CLASSES 9, 12, AND 15

ADAPTABILITY INDICATED BY SALES RECORDS

The adaptability of the B&W Integral-Furnace Boiler in the smaller sizes — classes 9, 12, and 15 — is indicated by the table below, which shows the application of more than a hundred boilers on the basis of size and pressure. It is noteworthy that 72 per cent of these boilers are for stoker firing and the remainder are for oil firing.

APPLICATION OF BOILERS			
By Boiler Horsepower		By Steam Pressure	
Boiler Horsepower Range	Per Cent of Steam Capacity	Steam Pressure Range, Psi	Per Cent of Steam Capacity
100–400	25.7	150–200	73.3
400–600	66.8	200–250	22.7
600–700	7.5	250 Up	4.0



B&W Integral-Furnace Boilers bring to the smaller steam plants major advantages of special importance under present conditions: Smokeless combustion, simplified operation, reduced costs of fuel and maintenance, and economical construction. Details of this unit, including additional data on sizes available and space requirements, are given in Bulletin G-34-A — sent on request.

The Navy "E" Award to the Barberton Works for production achievement is "an honor not lightly bestowed and one to be cherished."

G-230

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Roll Coating

(Shows the operation of converting "dope" into endless sheets of the familiar transparent film base which is nearly invisible as it passes over the polished rollers of the machines. Photograph was supplied through the courtesy of the Eastman Kodak Co., Rochester, N. Y., the city where the A.S.M.E. Fall Meeting is being held, Oct. 12–14. See pages 683–685 of this issue.)

MECHANICAL ENGINEERING

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GEORGE A. STETSON, *Editor*

A Glance at Education

EDUCATION concerns the engineer throughout the greater part of his life. As a child and youth he is caught up in whatever current of public instruction his community affords. With opportunity for education on the college level he exercises some choice of subject matter and institution. His postcollege education is practically entirely in his own hands, to continue or to abandon. For most men the formality of organized courses of study gives way to the informality of study for special needs, interests, and hobbies. But, formal or informal, the process goes on as the man himself develops and matures and as conditions place him not only in the position of student but also of instructor and administrator of instruction. Perhaps the needs of his children, perhaps the problems of his fellow workers or employees, perhaps the responsibilities of civic duties reawaken his interest in primary- and secondary-school education, or in the collateral branches of professional training followed by workers and technicians in apprentice courses, night school, and adult-education schemes, and bring him back again with objective vision and a background of needs and experiences to consider the extent and diversity of education. It is then that he considers seriously objectives, methods, finances, administrative controls, curriculums, and a host of problems affected by public policy and by private interest.

For many of us the war has provided the stimulus to thought about the needs and changing pattern of education. Into whatever level of education we inquire, the contrast of today with thirty years ago is great. The field covered by formal public education has expanded enormously. At all levels the vocational objective has become dominant, particularly in trade and professional fields. The number of years spent by the average person in formal education or training has increased. Education beyond the secondary-school level is being made available to a greater number of young people. Adult education at all levels has grown tremendously. Noneducational institutions, such as the major industries, have enlarged their interest and participation. Public school systems and publicly supported institutions have multiplied the number and enlarged the scope of their activities as well as the size and variety of their facilities. Objectives and techniques have reflected the temper of the times. Against the narrow but practical vocational utility of trade schools have been set off the self-disciplinary methods of educators who have seen in the shorter work periods of the machine age the need to prepare for the bored futility, born of too much leisure and fewer hours under the constraints of grubbing for existence, and the waste that comes of carrying too far, and without capacity or opportunity for intellectual profit, general studies whose greatest dividends may be paid in sophistication, frustration, or discontent.

Surely, the times and the shadows of things to come warrant a close look at education. It is prudent to assess needs and plan procedures. The engineers' war, which will terminate in an engineers' peace, points unmistakably to the obligation of engineers to concern themselves with educational problems. The subject is vast and complex. Prediction is unsafe, but a few random points may be made without getting too far afield.

The fact that the war has demonstrated a lack of trained workers in almost every field indicates that not enough attention has been paid in the past to apprentice and other vocational training. The desire, so universal for many years, to get into the "white-collar" class has turned to ashes in countless cases. The war, with its unparalleled destruction and accompanying dearth of goods to satisfy peacetime wants, will probably end, as all wars do, in a spurt of reconstruction and production that will afford abundant employment, if economic stability can be maintained. Competition for markets will be keen; the leisure that "threatened" the western nations will be delayed; "producers only" is likely to be the demand of the times, as Mr. Bevin has suggested in the British Parliament. It looks as though education would need to gear itself to satisfy this need.

Another educational need of the immediate future is for research workers. Here the engineer is actively concerned. Reconstruction will be at a subsistence level and the postwar boom will be short-lived if advances are not made in the field of research. We must have new things to make and sell. We must reduce the cost in materials and manufacturing time of what we do make. New materials, to replace those made scarce by wastage or inaccessibility, must be developed. An outlet must be found for the energies of men and the productive capacity of wartime plants, or the striking of an economic balance will close some of those plants at a time when the world needs goods and men need work. It is the obligation of educational institutions to train research workers to maintain the progress without which we shall fail and to assist as best they can in the solutions of the research problems themselves.

A third great field for education in the immediate future is in management and human relations. The only way the world can avoid the deadening effect of a subsistence level of living is to increase individual and collective productivity. Efficiency in the use of time,

energy (human and otherwise), and materials is best guaranteed by the co-ordinating influence of intelligent management. In the industrial field particularly management has become a function of men of engineering training and habit of mind. In other fields similar talents, based on identical principles, are required. Education must develop men for these tasks if it is to serve the future properly. But, as has been pointed out frequently in these pages, management has an important human-relations aspect that grows in value as democratic institutions develop. In fact, democratic institutions succeed or fail as these human relations are intelligently or otherwise handled. Education, and particularly the education of the engineer, must pay more attention to this aspect of the changing world.

What technological developments in transportation and communications have done to a world until recently existing in almost isolated communities, the war is teaching us, in this most favorably isolated continent, to understand. No educational program for the immediate or distant future can fail to recognize the obligation placed upon it of a world-wide outlook and still succeed in serving the nation that supports it. Not only engineers but every person must learn to throw off the curse of provincialism, not to take on the domineering role of an exploiting imperialism, but to discover the ways of peaceful living in an atmosphere of law and tolerance, an enlightened self-interest in competition that builds markets, trade routes, and friendliness, that breeds respect and confidence, and that affords equality of opportunity. This is a major task of education and perhaps the most difficult of all.

In a series of papers in this issue, a group of educators and engineers who have spoken before A.S.M.E. audiences take up several aspects of the problem of education. These papers are here presented for a larger audience, in the hope that engineers will give continued thought to one of the most fruitful problems facing them and their fellow citizens. They reflect credit on the Society that has men of vision to plan such programs and they arouse the hope that the A.S.M.E. may continue to make contributions to education on all levels.

British View of Production

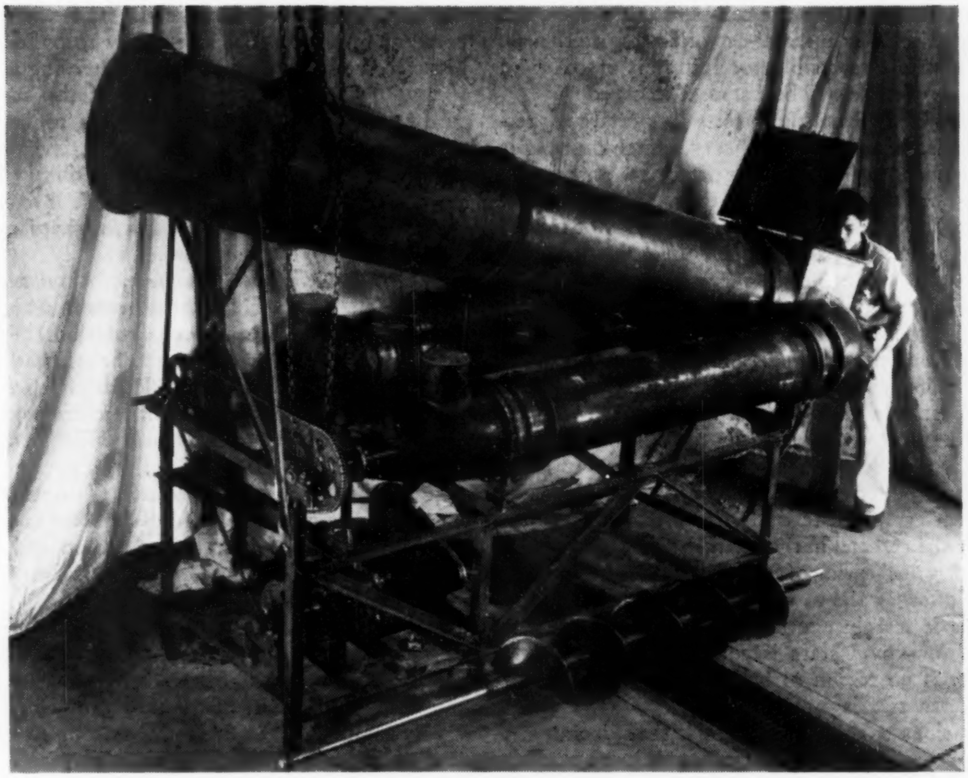
UNDER the caption "An Engineers' War," the *Economist* for July 18 comments on a speech in the House of Commons by Mr. Lyttleton, the recently appointed Minister of Production, and a memorandum (see *Engineering* for July 10) by the Institution of Production Engineers, a relatively young, but apparently virile, society of engineers. The memorandum suggests a fourfold approach to the problem of increasing production without increasing facilities already overstressed to the point where further additions of men, machines, and materials are extremely difficult to obtain. The four points made in the memorandum are: A more intensive use of machinery; the simplification of the design of weapons; a reduction in the number of types in production and increased specialization; and an improvement in manufacturing methods by making fuller use of the knowledge of production engineers. British comment on them is of general interest to engineers.

In regard to the first point the I.P.E. found that "the labor shortage is not so much a general shortage as a scarcity for shift working. Few factories are short of labor for day shifts, but there is apparently some unwillingness . . . . to do night work . . . . A better distribution of available labor among day and night shifts seems called for. In the view of the I.P.E., this could be brought about by allocating a larger proportion of whole-time workers to night shifts and by filling the resulting vacancies on day shifts by part-time workers . . . . Apart from the loss of machine-hours due to maldistribution of labor between shifts, output is also lost by the scanty use of the system of grouping small firms, many of which are comparatively inefficient . . . . Owing to the Government's policy of paying more attention to the limitation of profits than to the limitation of costs, the multitude of small firms have no incentive to grouping. In order to increase the over-all efficiency of small firms the I.P.E. suggests an extension of the powers of district clearing centers or, better still, the formation of district production groups responsible for the allocation of work according to productive capacity . . . ."

The extent to which costs of production can be reduced and resources economized by simplification of designs is convincingly set forth in the I.P.E. memorandum by data on specific cases. "In the view of the I.P.E.," the *Economist* comments, "the Supply Ministers should continuously explore the possibilities of modifying mechanisms in large-scale production, and firms manufacturing similar products might form product groups for the interchange of technical information and ideas."

On the point relating to standardization and specialization, the *Economist* says: "The I.P.E. holds that the standardization of war equipment offers a fruitful field for saving machine-hours. . . . . The reduction in the number of types also facilitates interchangeability and provides an insurance against the destruction of production facilities in air raids. In addition to the introduction of a greater measure of standardization, the memorandum suggests that resources would be saved by a reduction in the variety of products produced by individual firms. True, specialization has been deliberately avoided as an insurance against the consequences of air raids. It is suggested, however, that the safety-first policy of spreading contracts among a multitude of firms has been carried too far and that the premium represented by loss of efficiency is too high.

"Finally, the I.P.E. emphasizes the scope for improvement in methods of production. Large contractors employ highly skilled production engineers, but there are many small concerns which lack the advantages of expert advice. While this deficiency could be remedied by the formation of production groups, the I.P.E. suggests the utilization of the experience of its members who, for this purpose, would be prepared to offer voluntary assistance to small firms in their district. In view of the shortage of experienced production engineers, methods designed to 'spread' their skill might yield valuable results."



POLYPHASE CONTINUOUS FREEZING UNIT BEING ASSEMBLED

(Refrigerant jackets are yet to be welded to the 12-in. horizontal freezing tubes. One conveyer helicoid rests upon floor. Unit will be insulated with pipe covering.)

QUICK *and* FLASH FREEZING *of* FOODS

Fundamental Theories and Applications

By W. R. WOOLRICH[1] and LUIS H. BARTLETT[2]

THE term "quick-frozen" as applied to food is very elastic and much abused. Many cases are on record of products which have been frozen by methods that required as much as a week for complete solidification, yet they were labeled "quick-frozen." Such loose usage does not induce increased public confidence and acceptance. Too often the practice represents an attempt by some food processor to offer his cold-pack product under a classification that has the highest customer appeal in the food market. A previously proposed definition states: "Quick freezing is freezing at a rate sufficiently fast that there is no appreciable change in the physical or chemical properties of the product during the entire cycle of freezing and subsequent thawing" (30).[3]

The commercial food processor has little control over the method used to defrost his product except to print directions upon the package and hope the consumer will follow instructions. He does have control over the method of freezing and should employ the process which produces the minimum of change during this portion of the cycle.

More or less modification of any food may occur when it is frozen. Usually these changes are not apparent until the product has been thawed and in many cases further undesirable changes, due largely to enzyme action, may occur after defrosting is completed.

THEORIES ON CAUSE OF FOOD DAMAGE BY SLOW FREEZING

Several theories have been advanced to account for the effect

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[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

of slow freezing. These include the cell-puncture theory, the bursting of the food cells by internal-osmotic-pressure theory, and the theory of the irreversible precipitation of colloidal constituents. Each of these will be discussed in order.

Cell-Puncture Theory. Perhaps the most widespread and persistent hypothesis is the cell-rupture theory, which holds that the cell walls are punctured by growing ice crystals, and that upon thawing, the cell contents leak out through these minute ruptures (4, 12, 29). It is also held that, if the size of the ice crystals can be maintained less than the cell dimensions by rapid chilling, no puncturing with its consequent leakage will occur.

It should be borne in mind that foods are not composed of rigid inelastic cells. The walls are resilient and will permit considerable expansion before rupture occurs. Heat is removed from only one side of the cell so that expansion may occur on the opposite unfrozen side.

Microscopic observations conducted by the authors have revealed that, even when freezing is exceedingly fast, the smallest ice crystals are much larger than individual cells. Many cells are contained in one crystal instead of vice versa. The crystal lattice both inside the cell and in the intercellular spaces is continuous. No tearing or shearing of cell walls has been observed. The permeability of cell walls to water vapor or liquid is well established. This is merely another method of stating that water in the vapor or liquid state is continuous through the membrane. There is no reason to believe that attainment of the solid state interrupts this continuity.

In our investigations the technique which the mineralogist employs to prepare and examine thin sections of brittle materials has been adapted to frozen food. One side of the frozen specimen is cut to a plane surface which is cemented to a chilled microscope slide. The cemented specimen is now cut away to leave a thin section upon the slide. No distortion of the section to be examined occurs; and, since the entire operation is conducted in a refrigerated room using tools and apparatus which have been chilled to room temperature, the most delicate structure is completely unaltered. The prepared section may be protected against dehydration by a drop of chilled ice-machine oil and a cover glass.

A variation of this method consists of cutting a plane surface upon the unfrozen specimen, pressing the surface upon a clean microscope slide, and freezing by any desired method. The excess frozen material is then cut away, leaving a thin section adhering to the glass.

Examination of the section is accomplished by means of a petrological microscope which has a quarter-wave plate inserted between the crossed Nicol prisms. The illumination is supplied by a standard microscope lamp mounted at a distance and equipped with a filter to avoid heating the specimen under examination. The entire examination is conducted in a refrigerated room and every precaution is taken to prevent any change in the temperature of the specimen. Under these conditions, the product has the characteristics of a geological specimen and its crystalline structure can be so analyzed.

The field of the microscope and all isotropic substances are monochromatic, while ice crystals (which are anisotropic) present contrasting interference colors which are dependent upon the orientation of the crystal axes. The boundary of each crystal is clearly defined by the sharp color change and by the extinction which is successively observed in each crystal as the microscope stage is rotated. Cell walls and unfrozen portions are isotropic and exhibit no extinction or interference color (10).

Osmotic-Damage Theory. Petersen (17) proposed that damage to foods during freezing is due to the following mechanism: "What crystallizes first in each cell is pure water. That leaves the remainder of the juice in the cell more concentrated. The resultant increase in osmotic pressure tends to draw water from the next adjoining unfrozen cell. The water coming into the partly unfrozen cell has a tendency to build onto the crystals between the cells when the rate of freezing is so slow that the system approaches equilibrium." It also accounts for the occurence of collapsed cells contiguous to large ice masses in slowly frozen foods. However, this theory does not explain the damage which occurs in quick freezing when heat transfer so greatly exceeds diffusional rates at low temperatures that thermal equilibrium is attained before appreciable osmosis can occur.

Irreversible-Colloidal-Change Theory. Almost without exception perishable foods are colloidal systems in which the external or dispersing phase is an aqueous solution. This has led some investigators (16, 19, 22) to the belief that alteration of the colloidal structure is responsible for changes during freezing, storage, and thawing. While there are many factors which affect the stability of colloids, it is probable that only three concern the food processor.

1 The lowering of temperature (distinct from the freezing effect) renders many colloidal dispersions unstable. Examples are the formation of gels from agar, soap, and starch hydrosols. This phenomenon is often followed by syneresis, that is, shrinking of the gel and exudation of fluid.

2 Chemical changes which occur during frozen storage are irreversible. Many of them are due to enzyme action. The rapid deterioration of frozen unblanched vegetables is well known (26). The "rusting" of oily fish (oxidation of the fat) is very familiar (25). It is probable that some of the loss of flavor from stored frozen foods may be traced to hydrolysis of esters and oxidation of unsaturated odorous components.

3 Freezing causes concentration by removing liquid water from the external phase. More concentration, by decreasing the distance between dispersed particles may bring about critical instability.

Freezing may also effect sufficient concentration of electrolytes to cause "salting out" of hydrophilic colloids. While such precipitation is often reversible, long storage in this state may result in an irreversible precipitate. Bancroft (1), Weiser and Milligan (27), and Foote and Saxton (8) note that colloidal precipitates lose reversibility when allowed to age. Plank, Ehrenbaum, and Reuter (18) state that upon thawing haddock within 24 hr after freezing, the flesh is gelatinous and there is no exudation of juices. This texture slowly changes when the frozen material is stored and after 149 days is replaced by a fibrous structure which loses juices rapidly when thawed. H. F. Taylor (21) notes that slow-frozen haddock begins to lose juice when defrosted immediately after freezing, while the quick-frozen product does not; but after a few days in storage, the quick-frozen product will lose juices when thawed.

It is significant that the colloids which may be slowly frozen and thawed without damage are those which are not easily precipitated by electrolytes or which are free from electrolyte. Hardy (10) and Moran (15) describe the reversible freezing and thawing of gelatin gels. Egg albumen is commercially frozen upon a large scale without serious injury and the investigations of Kinoshita (11) and Thoennes (24) show that agar gels are reversible. It is well known that these colloids are not readily precipitated by salts of the alkalies, calcium, or magnesium.

Moran (14) notes that hen eggs maintain normal consistency when frozen in liquid air and rapidly thawed in mercury at 30 C (86 F). He has shown that colloidal changes in eggs occur between —6 C (21 F) and an undetermined lower temperature, and suggests that lipins, which dissolve at critical electrolyte concentration, are irreversibly precipitated when the concentration is decreased by thawing. Only negligible damage will occur, if exposure to the temperature range at which

these critical concentrations exist is made very short. In this case thawing and freezing rates are of equal importance.

Living leaf tissues have been frozen in liquid air and thawed both slowly and rapidly by Luyet (13). All slowly thawed samples were dead but many cells in the quickly thawed material were still living.

Artificial colloids, cheese, and eggs have no cellular structure to be damaged by mechanical rupture or by osmosis, yet they may be irreversibly altered by certain freezing technique. It seems questionable that continuous crystal growth, accompanied by progressive mechanical damage, could occur in frozen food which is stored at constant temperature over a long period of time. The deterioration of frozen foods in storage which has been reported by several investigators is probably due to colloidal changes. It is also hard to conceive that mechanical breakage could occur during either slow or quick thawing. The redistribution of water by osmosis requires much time which is not available during quick thawing. Chemical or colloidal phenomena only can account for these changes.

AN APPRAISAL OF THE THEORIES OF FREEZING DAMAGE

The freezing-damage theories might be appraised as follows:

Mechanical damage to cellular structures might be caused by ice crystals, especially for some classes of product. When this occurs, there is an internal shredding of the product, caused by growing crystals. The resultant damage is a function of the crystal size and freezing time.

Osmotic injury to cellular structure is possible but probably plays a minor role in the destruction caused by freezing. Water diffuses from unfrozen cells to the faces of growing ice crystals at a very slow rate. The action is irreversible when thawing occurs and might cause internal rupture.

Irreversible changes in the colloid system appear to be the principal cause for slow-freezing damage. Primary or secondary effects of low temperature cause irreversible precipitation of many colloids. This action is independent of cellular structure and explains the effect of freezing upon foods which do not consist of cells. The theory also accounts for the severe damage to some foods and the negligible damage to others when identical freezing technique is employed.

RAPID FREEZING RATES NOT ESSENTIAL TO ALL FOODSTUFFS

Many have a mistaken idea that very rapid freezing is equally desirable for all perishable foods that require preservation by cold. The need of rapid freezing is much more pronounced for some perishables than for others. Furthermore, the colloidal composition of some products is such that even slow freezing affects the structure but slightly.

With most foods that are to be cooked as soon as defrosted, slow freezing is as satisfactory as quick freezing. In the case of meats, slow freezing may even have a tenderizing effect. Furthermore, any leakage of the meat subsequent to defrosting merely results in increased pan juices.

Vegetables with a high starch content display a much different response to the freezing treatment from leafy types that may exceed 90 per cent of water by actual weight. Well-ripened berries and fruits with a high sugar content present a very different problem from acid and near-ripe fruit products.

VARIATIONS IN FREEZING RANGES OF FOODS TO BE FROZEN

The "freezing point" of any food product is that point at which freezing begins. An equally important physical factor in freezing is the temperature at which all of the free water of the product is completely crystallized. The temperature difference from the "freezing point" to temperature of the complete crystallization is considered the freezing range.

To assure a minimum of oxidation and thus reduce decomposition of a frozen food in storage, it is very desirable that crystallization of the water content be complete. The freezing and holding temperatures should be below the freezing range for successful freezing and subsequent storage.

Experiments by the authors indicate that the best commercial results will be obtained when the freezing and holding temperatures are held uniformly just below the freezing range of the product frozen.

The freezing ranges of foodstuffs vary widely, and freezing and holding temperatures that are quite satisfactory for one product may not be applicable to other products.

SUPERCOOLING PHENOMENA IN FREEZING COLLOIDAL FOODS

Supercooling of colloidal systems and of food has often been described in the literature, but its applications seem to have been overlooked by food researchers. The term "supercooled" is applied to a system which has been cooled to a temperature below its true freezing point without the formation of a solid phase. It is a thermodynamically unstable state and tends to revert to the stable condition with the liberation of energy. The change may be hastened by mechanical shock or by "seeding," that is, by introduction of particles of the stable phases. Supercooling is frequently observed in liquids of high viscosity and in colloidal systems. Since most foods fall into one or both of these classifications, the phenomenon is frequently encountered in freezing-preservation technique.

R. Brooks Taylor (23) has reported that strawberries immersed in sugar solutions held at 15 F do not freeze, but that diffusion occurs until equilibrium is attained between the syrup and berry juices. He further states that syrup temperatures below 10 F are necessary to secure freezing under these conditions. This is clearly a case of supercooling, since the true initial freezing point of strawberries is approximately 29.9 F (20), and at a temperature of 15 F about 50 per cent of the water content should be in the solid phase.

Our own experiments have shown that supercooling is largely prevented by "seeding" the external surface of the food with ice particles when the true freezing point is reached. Any food may be frozen at any temperature below its true freezing point if this technique is employed.

Supercooling in itself is no disadvantage for food preservation. Moran (14) reports that fresh hen eggs, which have a true freezing point of —0.6 C (31 F) have been supercooled to —11 C (12 F), held for 24 hours, and then warmed to room temperature without change; but if freezing occurs below —6 C (21 F), the character of the thawed egg is changed. If foods could be supercooled to 0 F and held indefinitely in this state, excellent preservation would be possible. At this temperature microorganisms are inactive, enzyme and chemical changes are slow, and the supercooled colloid structure is largely unchanged. Unfortunately, solid phases appear in many foods at high temperatures. In this case supercooling is a real disadvantage.

The three principal operating disadvantages of supercooling are:

1 The over-all rate of heat transfer is reduced, necessitating a longer freezing period and reducing the capacity of the freezing machine.

2 When heat transfer is accomplished by means of a chilled fluid, soluble components of the food diffuse into the fluid until the food surface is essentially solidified. Some of these components possess flavors and colors which might be undesirable in subsequently frozen batches. Juices dilute the freezing medium and make it necessary to reconcentrate periodically and to remove accumulated gummy substances.

3 Unnecessary damage is caused by freezing a colloidal system after severe supercooling. Callow (5) has shown that the linear rate of ice formation is 1680 cm per hr in 1 per cent gela-

tin gels which are seeded after supercooling. This is enormously in excess of any possible rate of advance of a uniformly frozen boundary. It may be shown that approximately 400,000 Btu per sq ft per hr must be removed from food to freeze uniformly a slab at this rate. This means that when the phase change is inaugurated in chilled food, filaments of frozen material form in the supercooled zone and rapidly extend far beyond the uniform boundary. Latent heat of fusion is released, and the concentration of the solutes in the external colloid phase is increased. This combination of increased temperature and electrolyte concentration accounts for the precipitation of many colloids in the unfrozen space between the filaments.

EXISTING COMMERCIALLY USED QUICK-FREEZING PROCESSES AND FREEZING EQUIPMENT

The principal agents that have been developed for the quick freezing of foods are:

1 *Cold-Air Blast.* Cold-air currents are sometimes used in insulated tunnels through which the product to be frozen is progressively advanced at a rate sufficiently slow to permit the solidification of the product before it emerges from the tunnel. In other designs the tunnel is equipped with a rotating cylinder slightly inclined and operated quite like a gravel screen. In air freezing the rate of heat transfer from product to still air is relatively low and the devices used to increase this rate are rapid movement of air, large temperature differentials between air and product, and keeping the surfaces of the product well exposed to the circulating air. Temperatures as low as —45 F and air velocities of 5000 fpm have been advocated. Cold-air-blast freezing is more acceptable for small articles or products than for large pieces. Because of the much higher ratio of exposed surface on small specimens, it is more satisfactory for peas, spinach, and small berries. It is successfully used on meats where a high rate of freezing is not so essential.

Great care must be exercised in freezing some products by cold air to assure a low dehydration. If loss of weight is a vital factor in the freezing process, then cold-air freezing should be very closely controlled and a high humidity maintained.

Two-stage blast freezers have been proposed to minimize dehydration, by maintaining small temperature differentials between the product and the circulating chilled air. Thus when the food has been properly prechilled in the first stage, it is transferred to the second stage where contact with much colder air completes the freezing.

Much of the quick freezing by cold air is no different from the sharp-freezing practice that existed many years before quick freezing was introduced. In cold storage the use of air at very low temperature is usually classed as "sharp freezing." However, where the cross section of the product is small or the ratio of exposed surface to weight is large, cold-air-blast freezing can be rapid enough to qualify properly as quick freezing. Large quantities of fish are frozen by the cold-air method, then sprayed with ice water which immediately solidifies to a protecting ice glaze.

2 *Metal Plates and Metal Pressure Surfaces.* Metal plates have been used successfully for quick freezing since the inception of the industry. The fact that metal has a very high rate of heat transfer, that it can be used with the refrigerant on one side and the product to be frozen on the other side, and that plates are part of the conveying devices, has made these processes very satisfactory and attractive to inventors.

Many devices have been described in which a loose product, such as berries, peas, and lima beans, are moved by conveyers while in contact with chilled metal surfaces. One type consists of a refrigerant-jacketed horizontal metal tube through which material and air are carried by a screw conveyer. Another type employs an inclined chilled tube, having an internal screw thread, through which loose product and air are conveyed by rotation of the tube. Yet another variation employs horizontal metal plates, over which the food is pushed by scraper blades.

In some equipment a single-plate system is used, the refrigerant side being chilled by direct expansion or by brine, either sprayed or allowed to flow over the surfaces. In its very simplest form the plates may be stationary and the foodstuff presses onto the single plates. In other designs the plates may be movable and pressed against the product to be frozen.

In the more highly developed systems, a double-plate design is often employed. For example, in one system, the products to be frozen are placed on a flexible conveyer belt which carries the product parallel with and against a second refrigerated metal belt. As the product, which is usually packaged, is carried between these two metal surfaces, it is frozen to the desired degree by controlling the speed on the belts.

In another system, the two refrigerated plates are the upper and lower refrigerated platens of a press. The package is placed between these pressure plates, the press set into operation, and the freezing occurs with the pressure plates holding the package firmly until frozen.

The principal disadvantage of most plate freezing processes is the need to place the product in a package before freezing. Most packaging material is of an insulating nature. Thus the advantage gained in rapid heat transfer through the metal is largely lost in the insulating properties of the package.

One large processor has recently developed the double-plate system to operate without the disadvantage of having the package-insulating material between the product and the plates. The freezing is done by direct contact of the product with the plates, then the product is quickly detached from the plates by a sudden momentary warming of the plates. The advantage of rapid heat transfer in freezing is expected to more than offset the loss due to the intermediate warming between freezing periods in the cycle.

3 *Cans.* Considerable research and some commercial development has been successful in quick freezing in cans. The chilled product is sterilized, canned, and sealed, then submerged in a low-temperature brine for a sufficient period to freeze to a low temperature. A high heat transfer is obtained by rapid circulation of the brine over the cans, by movement of the cans and by agitation of the product in the cans. One interesting method of freezing foods in hermetically sealed packages utilizes immersion in a bath of evaporating liquid propane. Another method proposes that containers which are not wetted or affected by mercury are to be immersed in a chilled bath of that metal. For certain products, this is satisfactory, but there are many to which such a process cannot apply.

4 *Liquids for Immersion and Spraying.* Immersion and spraying systems were recommended nearly a century ago. A large number of liquids have been proposed for freezing foods by direct contact. Aqueous solutions containing common salt are suggested for treating meat, fish, and vegetables. Variations include the incorporation of ethyl alcohol, glycerol, potassium nitrate, and sugars. One composition of water, salt, and sugar is said to possess a neutral flavor. Solutions containing water, glycerol, and ethyl alcohol have been proposed. Sugar syrups and solutions containing invert sugar and other soluble carbohydrates have been successfully used to freeze fruits. Concentrated fruit juices or juice fortified with added sugars have also been proposed for fruit freezing. Poultry has been frozen by submerging in a bath of evaporating liquid carbon dioxide, recovering the gas, and reliquefying the carbon dioxide. It has been suggested that fruit juices might be quick-frozen by admixture under pressure with liquid propane in such proportions that, when subjected to reduced pressure, the propane

would be completely volatilized and removed from the frozen juice.

The merits of various immersion liquids have been widely discussed. It may be pointed out that some foods frozen by the older methods of direct contact with brine may retain an undesirable quantity of salt. Ethyl alcohol is very definitely objectionable to a large group of American buyers and in addition is so hedged about by governmental restrictions that its accepted use in a freezing fluid for foodstuffs seems unlikely. The market price of glycerol fluctuates widely, while at the present time it is a necessary raw material for the manufacture of vitally needed explosives. Sugar is rationed, but since it is a well-recognized food and also a very effective agent to inhibit the deteriorating effects of oxidation and enzyme action upon foods, it seems probable that food processors will be permitted to secure the quantities necessary to formulate freezing media to assist the war effort.

The fog-spray method was introduced in the United States by Zarotschenzeff (31). The products to be frozen are sprayed with atomized brine either in cartons or directly on the product. The liquid is collected, refrigerated, filtered, and recirculated by means of a pump. This system is very effective but has not had as wide an application in this country as it deserves.

The liquid-immersion method of freezing, described by Ferris and Taylor (6), using either a saline- or a sugar-immersion bath was reintroduced commercially by the research divisions of the Tennessee Valley Authority and has been found to be very satisfactory for berries, peaches, solid vegetables, and marine products. Their patents cover several features of immersion-freezing.

Freezing foodstuffs by direct contact with a chilled fluid has several advantages over other methods. Especially does it afford a high rate of heat transfer with a relatively small temperature differential. The resultant product is exceptionally good.

It was in this field of fluid-contact freezing, as applied to Gulf coast fish and marine-animal products, and to southwestern fruits and vegetables, that the authors were conducting their research investigations when they observed the highly desirable effects which were obtained by freezing in subcooled sugar and saline solutions. This led to the discovery of "polyphase freezing" or what some prefer to call "flash freezing."

THE NEW UNIVERSITY OF TEXAS POLYPHASE FREEZING PROCESS

Controlled supercooling and favorable colloidal action are utilized in The University of Texas polyphase freezing process to flash-freeze foodstuffs. Unusually fast heat transfer is secured by direct contact of food with a chilled medium of high viscosity which is composed of three phases: Solid, liquid, and vapor, hence the term "polyphase." A typical medium is composed of dextrose, sucrose, and water. It is chilled and slowly agitated until a solid phase of finely divided ice particles has formed and is dispersed throughout the liquid. This composition is satisfactorily operated over the range —2 F to —10 F and is metastable at these temperatures.

Articles of food are floated in the cold medium and the slow agitation moves the articles with respect to the fluid and also to each other so the individual pieces are prevented from freezing together. Freezing is so fast that washwater or juices adhering to the food surfaces are at once frozen in place and do not dilute the polyphase medium. This film of ice is proof that diffusion of soluble constituents does not occur, solute is not transferred from the freezing medium to the food, nor does the food lose dissolved solids.

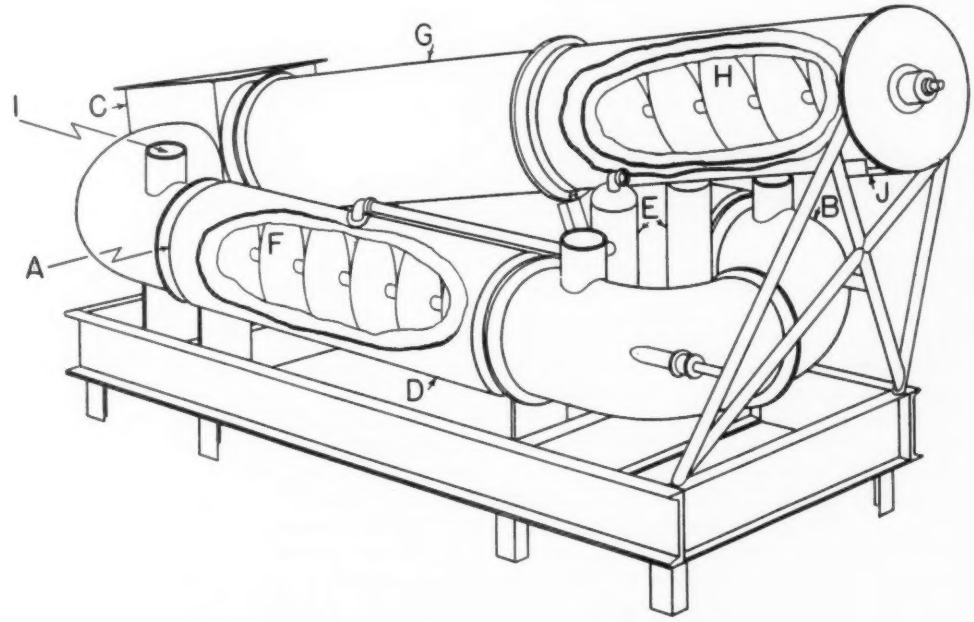
The high rate of heat transfer is due to three factors:

1 The extremely high thermal capacity of the polyphase state (2).

2 Increase in the thermal conductivity of the fluid film by the suspended ice particles.

3 Almost complete elimination of food supercooling by the "seeding" effect.

The polyphase medium removes heat approximately twice as fast as a liquid medium under identical operating conditions (3). Polyphase media, composed of water and sugars, may be operated in the metastable state at temperatures as low as —10 F,



THE UNIVERSITY OF TEXAS POLYPHASE FLASH FREEZER

(*A*, Freezer tube; *B*, return connection to second freezer tube; *C*, junction box housing separating grid; *D*, refrigerant jacket; *E*, refrigerant surge drums; *F*, freezer helicoid conveyer; *G*, drainer-tube housing; *H*, drainer helicoid conveyer; *I*, feed port for unfrozen food; *J*, discharge for frozen food.)

FEED COMPARTMENT OF THE UNIVERSITY OF TEXAS EXPERIMENTAL POLYPHASE FLASH-FREEZING UNIT, OPERATING UPON VALENCIA ORANGE SEGMENTS

while syrups employed in food freezing are seldom operated below +3 F. Thus it is possible by employing the polyphase media to chill foods in a fraction of the time required by liquid media under ordinary operating conditions.

It has been demonstrated experimentally that the polyphase medium removes a given quantity of heat from cubes of carrot in approximately one half the time required by a liquid medium when the fluid temperatures and other operating conditions are identical (3). It remains to show the effect of the low operating temperatures which are successfully used by The University of Texas polyphase freezing process.

Let it be assumed that it is desired to remove sufficient heat from carrot cubes so that the temperature of their centers is reduced from an initial value of 77 F to 4 F. The first portion is to be chilled by contact with a polyphase medium held at —10 F, while the second will be chilled under identical conditions except that the medium will be held at 1.5 F. By means of the Williamson and Adams method (28), it may be calculated that the ratio of the required time periods is approximately 1:2. Thus it may be stated that a polyphase medium at —10 F will freeze a given article of food in approximately one fourth of the time required by a liquid medium at 1.5 F.

An important advantage of heat-transfer fluids which can be operated at sub-zero temperatures is that freezing is completed in one operation and no heat is removed in the storage room. By eliminating this period of exceedingly slow cooling, less irreversible damage to the colloidal structure occurs, and a more immediately practical result is that the food does not freeze into a solid mass in the container. Each piece retains its individual character so that it may be removed without disturbing the remainder and repackaging in smaller packages is easily accomplished. Many desirable characteristics of loose-pack frozen foods are emphasized by Flint (7).

After chilling is completed and the food is removed from the freezer, a film of metastable medium remains upon each article. This film will eventually pass to the stable state in storage but it is better to accelerate the change by dusting the frozen product with a minute amount of dextrose. During stabilization, the coating is changed to a plastic material, consisting of finely divided sugar and a viscous syrup, which adheres tightly to the frozen food and serves as an envelope to retard oxidation and dehydration. Tressler and Evers (26) state that sugars markedly inhibit oxidation and other enzyme action in foods.

THE POLYPHASE FREEZING MACHINE

One basic requirement of any food-freezing process, which utilizes sugar solutions as heat-transfer media, is a type of machine which can successfully handle very viscous fluids. The University of Texas polyphase freezer is such a mechanism. The heat-transfer unit is a refrigerant-jacketed horizontal tube, partially filled with polyphase medium, in which a closely fitting helicoid conveyer operates. This tube terminates in feed and discharge compartments which are connected by a fluid-return conduit. A suitable grid in the discharge compartment retains the frozen food and allows the polyphase medium to return to the feed chamber. Normal rotation of the screw propels the fluid and food, while a superimposed circular oscillation provides agitation. Speed may be regulated to allow complete chilling of articles of various sizes.

Small machines employ one freezer tube and one helicoid conveyer. Food moves in a straight line from the feed end to the discharge compartment grid, whence it is removed periodically

to a refrigerated drainer compartment before packaging. The heat-transfer medium flows through the grid and through the return conduit to the feed compartment. Large units have parallel twin freezing tubes, connected at one end by a return bend and at the other end by a junction box which is divided into feed and discharge chambers by a curved grid. Food moves in a U-shaped path to the grid, from which it is removed and propelled through a chilled perforated drainer tube by an auxiliary screw conveyer before delivery to the packaging equipment. After passing through the grid, the heat-transfer medium repeats its cycle.

The mechanical advantages of The University of Texas polyphase freezer are:

1 Extremely simple design.
2 Compact and light in weight.
3 Low power consumption.
4 Continuous in operation.
5 Small area to insulate.
6 Low maintenance cost.

The desirable operating characteristics are:

1 Very high rate of heat transfer from the polyphase medium to the refrigerated surface.
2 Highly viscous heat-transfer media successfully handled
3 Small quantity of medium required.
4 Working temperature quickly attained.
5 Ease of maintaining the freezing medium in a commercially satisfactory concentration.
6 Standard condensing units, without boosters, are used to furnish refrigeration.

The process has been thoroughly tested upon both laboratory and semicommercial scales. Approximately 6000 pounds of food have been frozen, including most important varieties which are produced in the Southwest with the exception of leaf vegetables. Meats, poultry, fruits, and vegetables were frozen by the sugar-and-water polyphase medium, while shrimp were frozen in a high-viscosity water-and-salt polyphase medium. The excellence of vegetables frozen and coated with the sugar media has been amply demonstrated (3). Articles from the size of a pea to the limiting dimensions of the freezer tube have been successfully frozen.

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EDUCATION *and* INDUSTRY

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NEVER before in history, at least the history of the United States, has there been need for a closer tie-up between education and industry. Since the eventful Sunday of December seventh, "teamwork" is and will be the watchword until America and the other free countries will have completely crushed out of existence all forms of dictatorship.

Hitler put a premium on educating the youth of Germany, not to create culture and a more sympathetic attitude toward mankind, but to inculcate in young minds hatred against everything opposed to the doctrines of Hitlerism. He will undoubtedly build up a Frankenstein that will rise up and crush the perpetrators of such a dastardly philosophy. Might was never right; and in the opinion of your speaker, the doctrines of Christianity, spoken to us by a Wise Man a little less than two thousand years ago, will be the only set of laws that this troubled world can settle down to with any degree of certainty that there will be peace on earth, good will toward men.

My interest in education is quite intense, and what I have seen and experienced for the last ten years in my connection with Illinois Institute of Technology—formerly Armour Institute and Lewis Institute—has given me a little keener insight into the value of education and what it is doing for the youth of America.

It may interest you to know that when Armour Institute and Lewis Institute were merged, there was created in Chicago the largest technological center in the United States, with a registration of a little over seven thousand students when computing the attendance on both the day- and evening-school classes. The division is approximately 2000 in the day school and 5000 in the evening school. The day-school students are instructed in subjects such as mechanical, electrical, chemical, and other branches of engineering and science, also architecture and fire protection. More than 500 students are enrolled in the co-operative courses requiring work and study alternately for six-week periods for five years, before receiving a degree. Evening classes give instructions on a college level to employees of industry from foremen up to chief engineers and heads of companies. The courses range from elementary to postgraduate work. Approximately 15,000 men will be given training in co-operation with the Government Defense Plan.

Here you begin to see the urgency of continuing education. Naturally, being a trustee, I get only glimpses of the practical workings of education, but results have shown me very definitely the progress which takes place in the "thinking caps" of these young men. Raw recruits they are when they come to us, but quite a finished product when they leave and enter industry.

A democracy, to be successful, must be made up of intelligent, well-informed citizens—of *educated* individuals, capable of making decisions for themselves. America is not a country which seeks to keep its people ignorant so that they can be easily herded into the paths a dictator wants them to follow. Since this country was founded it has placed emphasis on individual thinking and initiative. No other country in the world has provided so freely and so well for the education of all its citizens.

Contributed by the Committee on Education and Training for the Industries and presented at the Semi-Annual Meeting, Cleveland, Ohio, June 8–10, 1942, of The American Society of Mechanical Engineers.

OBLIGATIONS OF INDUSTRY TO EDUCATION

Industrial management looks to the schools for its new employees. It wants young people endowed with the spirit of individual initiative, with faith in the traditions and institutions of America. It wants employees who have been trained to think and who have basic information which enables them to adapt themselves to their productive tasks and to the people with whom they work. Manufacturers believe in education—they are sympathetic toward it and enthusiastic about it. They want every American to have all the education he has the capacity to absorb.

Industry has an obligation to society to produce the goods on which our high standard of living is based, to provide jobs and income, and to produce wealth for the support of education and the cultural institutions which go to make up a high form of civilization.

Education has an obligation to society to educate young people to take their places as worthy citizens. It should teach not only objective facts but ideals and principles. It should help young people to develop a workable philosophy of life, not merely push youth out into the stream of life like a ship adrift without a rudder. Education should prepare youth to take positions not only as employees, but also as employers. Our future progress depends upon the incessant emergence of new enterprises. There must be men with the courage, the fortitude, the foresightedness, and the willingness to take risks and make sacrifices which are essential to private enterprise.

Manufacturers and businessmen are deeply interested in seeing to it that every American has an opportunity to receive the amount and kind of education which will best serve him and society. Business and industry cannot operate without employees, and it is to the schools of the nation that we must look for the young men and women who will have the ability and philosophy essential to maintain and advance America's industrial supremacy. The success of our industrial civilization depends not only on the development of the capacities to be effective employees, but also on the development of the qualities required to be good employers—enterprisers who will create new jobs, new improvements, new opportunities.

FUNCTION OF EDUCATION TO DEVELOP UNDERSTANDING OF AMERICAN TRADITIONS

Manufacturers are optimistic about America. They have first-hand experience with the emergence of new goods, new services, new industries from the ideas of inventors and research scientists. They recognize a new economic frontier which has displaced the old geographical frontier. They know that the future can be far more glorious than the past if we keep open the channels of individual expression in every phase of American life. One of the major functions of education is to develop an understanding of the appreciation for the institutions and the traditions which have made this country great. The aims of education and of industry, from the standpoint of national and individual welfare, are the same. By co-operation and sympathetic understanding of each other they can assure continued progress for this nation which has already outstripped the rest

of the world in providing for the material, cultural, and spiritual aspirations of mankind.

Defeatists have told youth that America used to be a land of golden opportunity but that opportunity is now dead. They say that the rising curve of progress has leveled off, if not declined. All of this is supposed to have taken place as the result of the passing of our geographical frontiers. This is the "mature economy" philosophy.

The fact is that our geographical frontier has been displaced by a technological frontier offering opportunities undreamed of by our forebears. Every American, particularly youth, must recognize this significant, dominant, economic trend away from the exploitation of nature and raw materials to the exploration by scientists and inventors of the new frontiers found in the shops and laboratories of industry.

End of Progress Not Yet Reached

Have we reached an end of genius and inventiveness? Have we reached an end to the improvement of the physical world in which we live? Have we reached a point where human desires are all fulfilled as far as we can fulfill them? What *does* the future hold?

When anyone predicts that the America of tomorrow will not be more wonderful, happier, better than the America of today, let us recall Henry L. Ellsworth, United States Commissioner of Patents, who in 1844 said:

"The advancement of the arts, from year to year, taxes our credulity and seems to presage the arrival of that period when human improvement must end."

Commissioner Ellsworth spoke before the advent of electricity, the airplane, the motorcar, the telephone, the radio, the motion picture, and all the host of things developed since that time. At the very time he spoke Elias Howe was working on the sewing machine and Charles Goodyear had just made his great discovery of how to vulcanize rubber.

Yet fifty years later there were still doubters who would have people believe that the end of human progress had come. In 1886, at the very beginning of our vast power era, Carroll D. Wright, Federal Commissioner of Labor, stated:

"It is true that new processes of manufacture will undoubtedly continue and this will act as an ameliorating influence, but it will not leave room for a marked extension, such as has been witnessed during the last 50 years . . . . There may be room for further intensive, but not extensive, development of industry in the present era of civilization."

And there are doubters today, blind men who shut their eyes to the many new and marvelous developments that point the way to the future.

Seeing, then, that there is opportunity today, youth wants to know how it can achieve its destiny.

First of all, too many youths want the world on a silver platter—they want to start at the top instead of going through the experiences and hard work those at the top today have gone through.

A Few of Our Problems

Here are a few of our problems. Our growing demands for new goods and new services cannot be satisfied by natural products alone. We must outdo nature in the laboratory. In every field of endeavor there is enough unfinished business to supply thousands of problems for industry and science to work on. Here are a few of the jobs that need to be done—what an opportunity for youth!

New Products. New plastics and synthetic materials with properties of which we have no inkling now.

Family airplanes, as safe and easy to operate as an automobile, and traveling at speeds now only dreamed of, and capable of landing on top of a flat-roofed building.

Material to which ice will not adhere, for use on airplane wings, highway surfaces, windshields, etc.

Low-cost air-conditioning equipment for automobiles.

Nonshrinking mortar.

A material for dissipating static electricity from paper, driving belts for machinery, artificial silk, etc.

A machine that will convert sound vibrations of the voice directly into printed form.

Television on the 'phone, so that the other person's face is visible.

A permanent mothproofing agent.

Cast iron that would bend rather than break under stress.

Waterproof paper.

Development of a form of rubber that will keep its traction on wet surfaces.

Development of a tobacco that leaves no ash.

New Industrial Processes. Cheaper methods of producing electricity, to make it available in new industrial fields.

New sources of tremendous energy to be released from the atom.

Noninflammable lumber.

A synthetic process for producing carbohydrates and hydrocarbons from the air.

A successful process for preserving bread by freezing.

A device to make the waste energy from exhaust gases and utilize it for jet propulsion at very high speeds, thereby adding to the performance of aircraft by the utilization of power now wasted.

A machine to weld pieces of lumber into an endless board.

A method of making copper and brass stainless.

In the Home. Millions of additional homes, to be built with conveniences now undreamed of.

Electricity for millions of families now doing without it.

In homes already wired for electricity, more labor-saving electrical appliances. A recent survey revealed a $16,000,000,000 market in this field. To satisfy it would keep 1,000,000 persons at work for four and a half years.

For Agriculture. Electric farming, including the heating of the soil to force crops.

A "binder" for soil to keep it from being carried away by erosion.

Insect control by a death ray or a controllable fumigant, not harmful to animals or humans, for farm and garden use.

Miscellaneous. Air-conditioned cities, some say, glassed over and maintained at constant temperature and humidity the year round.

Superhighways that eliminate curves and grades to provide safer transportation.

Solutions to such problems as these: What is friction? Why is glass transparent? Why are some substances good conductors of electricity or heat or sound? The answer to any one of these questions might lead to vast new industries.

Methods for dispelling fog over airports.

An economical method of storing winter cold for summer use and summer heat for winter use.

Improved methods for eliminating noise.

Charles F. Kettering, vice-president in charge of research, General Motors Corporation, said:

"I have been looking for somebody that will invent a word for me, and the word that I want them to invent means exactly the opposite of what history means. History is looking back; it is the most fixed and unalterable thing in the world. I want

some educated person to invent a word which means looking to the future what history does to the past."

ACHIEVEMENTS OF FREE INDUSTRY

I have been talking of education. Now let's take a look at industry. The eyes of free men everywhere are on American industry, as it produces the guns, tanks, planes, and other weapons to defend our freedom.

Within one year free men and free industry in America have stepped up armament production more than Hitler with his much-vaunted regimented economy did in five years. Originator of mass production, American industry now "outmass-produces" the world.

Typewriter factories, sewing-machine plants, and lawn-mower shops which made goods for peacetime needs now are converted to arsenals through the ingenuity of American industrial engineers.

America was the mother of mass production and it has led the world in the application of it to production of the necessities and luxuries of a high standard of living. It now turns this superior ability to armament production and will attain the same superiority in that field.

The principle of interchangeable parts upon which modern mass production is based was first developed by Eli Whitney, inventor of the cotton gin. Significantly, he put the principle into effect when he received an order from the United States Government in 1798 for 10,000 muskets.

Previously muskets had been made by hand and Whitney was severely criticized when, after several months, there was no evidence of muskets—only special machines he was developing to make the parts. He amazed the experts when he went to Washington with a box full of gun barrels, stocks, hammers, triggers, and other parts and assembled complete guns from the parts picked at random. Nothing like this had ever been done before.

In describing this incident, Roger Burlingame says in his book, "March of the Iron Men:" "It is extremely doubtful if anyone in the room saw in the demonstration the whole basis of all future mass production in the world."

Through invention, research, and technical improvement industry has aided defense by giving America:

A machine which bores an airplane propeller in six minutes, whereas it used to take an hour.

Twelve-cylinder airplane engines which will develop 1040 horsepower compared to 400 horsepower in the last war. Today's engines will run 600 hours without overhauling; those of 1917–1918 had to be overhauled after every 50 hours of flight. Speed of planes has been increased from 100 miles an hour to more than 400 miles an hour.

Synthetic rubber which may, in time, fill all of our needs and make us independent of importations of raw rubber.

Nylon for parachutes, instead of imported silk.

Chemically treated cotton for powder bags, instead of imported silk.

The Garand rifle which can be fired accurately 60 times a minute, compared to the rifle carried in the last war which shot 15.

Submarines with a cruising range of 16,000 miles, compared to the 10,000-mile range in the last war.

New metal alloys.

INDUSTRY SHOULD NOT BE HANDICAPPED

Industry recognizes the emergency America faces and responds with all-out effort. It should not be handicapped. But there are many obstacles to maximum speed and efficiency in America's armament program. Let us face them squarely before it is too late, and not trust to fate as tragic France did.

A most serious obstacle is the strike situation. In five months 3,594,000 man-days were lost, perhaps the equivalent of enough to have produced the planes, tanks, or guns required to turn the tide of battle in many a recent crisis.

Strikes have been dangerously minimized by government and labor spokesmen, but the truth is that no strike in an all-out defense effort can be considered unimportant.

Adaption of a sound national labor policy is the first step in the direction of solving the strike menace.

As gigantic as the defense job is, consumers will still look to industry to produce the vital goods for civilian life. "Business as usual" is no longer the order of the day in industry, and the public, too, must expect the defense program to affect normal living. Sacrifices which all should be willing to bear will be called for to protect the freedoms all Americans cherish.

Priorities will be felt when consumers seek many items they are accustomed to buying.

Price rises will be inevitable in some lines, although industry has pledged itself to avoid all unjustified price increases.

Consumers can help by avoiding hoarding and by adapting themselves to any shortages which may occur.

We must expect to pay higher taxes now to avoid disaster in the future—"Bleed now to avoid anemia later." But the voice of democracy must insist that wasteful nondefeuse spending be stopped. The nondefense budget of the Federal Government has doubled in the last decade.

As we produce arms to defend freedom in other parts of the world, let us keep our eyes on the goal at home. What will it profit America to defend freedom abroad and lose it at home?

It is imperative that all America guard against the adoption of controls over industry and over the lives of free men which cannot or will not be released after the emergency.

America's future depends upon the preservation at home of the American way of life. Let us analyze and understand what we are arming to defend and take care that we do not sacrifice the American way of life as a price for becoming an arsenal.

Although in a sense America was caught unprepared, in that industry had not been asked to produce armaments on a large scale until the summer of 1940, the truth is that American industry began its "preparedness program" 150 years ago when the groundwork for the present industrial system was laid. The "secret" of defense today is a superior productive system. America has what it takes.

Yes, all America looks to industry for defense. The challenge is to industry, and industry accepts the challenge. Given the efficiency of free industry and the co-operation of free workmen and our free government, we can and will make America invincible.

Roy W. Moore, president of Canada Dry Ginger Ale, Inc., said before war was declared:

"What does business expect to get out of this period of emergency? Not swollen profits. Industry is no parasite which sucks the nation's economic blood.

"Not freedom from attack. Not life of ease. But sleepless nights and grinding days, fraught with worry and cargoed with care, while we plan and strive, each of us without stint, to make best *better* in our accomplishments on freedom's behalf.

"And when this war is over, and the defense emergency is past, more sleepless nights and grinding days while we labor to convert industry back to the service of peacetime economy.

"This we expect. And our reward? The greater glory of industry's shining name. The safety of the economic system that has made America great. And the safety of all freedom."

PAST *and* FUTURE EDUCATION *of* ENGINEERS

By C. E. MacQUIGG

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IN attempting to discuss a subject as broad as the one "Education and Training for Industry Before and After the War," it will be necessary to mention only a few of what may be many trends. If one agrees with the French philosopher who said, "All generalizations are false, including this one," then little safe ground is left to make sweeping assertions.

Based on the total history of higher education, formalized education of engineers has been a fairly recent development. True it is that pioneering work by the U.S. Military Academy at West Point and by Rensselaer Polytechnic Institute goes back more than a hundred years; but popular education of the technical man for the practice of engineering appears to have received its greatest emphasis as a result of the establishment of the land-grant college and university. Although the federal law establishing this type of institution was passed during the administration of President Lincoln, the schools springing from the Act did not begin to exert widespread influence until in the 70's and later.

ENGINEERING EDUCATION IS CONSERVATIVE

By and large the education of the engineer has been conservative and the reasons for this are obvious. Quite properly it has been a tradition of engineering education that facts and not fancies must be adhered to. Without a doubt, those men who formed the mold of our engineering philosophy—as much as it is possible for such molds to be established—rightly held the highest standards of intellectual honesty. Fortunately, it was unthinkable to them to temporize with untried theories and naturally the men whom they trained as engineering educators carry this philosophy in turn to their students, thus handing down the tradition of stability.

This innate conservatism, which is inculcated into the thinking of the engineer, is proper for a number of reasons, an important one being the fact that generally the work of the engineer concerns risks which may involve human lives. The bridge must endure; the dam must not pass away; the ore reserve must last at least until its expected period has permitted amortization and the return upon the investment. (Such has been the philosophy learned in the school of experience, but many events of the past decade would seem to be quite in contrast to such a philosophy.) On the other hand, those dealing with, say, the "humanities" seem to feel free to allow more complete expression of theories and even fancies. If some social venture collapses about their heads the result appears to be less disconcerting than if the ideas had been represented in reinforced concrete.

Another reason for conservatism in engineering education is that technical progress has been dependent not only upon ideas but upon the existence of facts. Since facts are sometimes slow to accumulate, the engineer has been at a disadvantage with respect to the more rapid progress seemingly made in certain nontechnical areas where, unfortunately, it sometimes appears that facts are bugbears to be carefully avoided.

What has been said so far refers to the designing engineer, and the inventor is specifically excepted. Many inventors have not been technically trained, consequently, they have not been inhibited in any way.

However, the contrast between invention and technology does not need to be examined here.

PRODUCTS OF EDUCATION

In thinking of education along science lines today, we may classify the products as follows:

1 The scientist may or may not be the product of one of our so-called technical schools; he is more likely to graduate and then take postgraduate work in some rather intensified area. He may have high proficiency in mathematics, but not necessarily so. He almost certainly has great proficiency in physics or chemistry or biology. His "usefulness" is generally measured by the more or less immediate practicability of his output, although this is sometimes denied by those who discuss "pure" versus "applied" science. The education of such a person must be along paths of extreme specialization, else he will not acquire that mastery of detail which makes him a scientist.

2 The technologist is educated to know principles and processes in what usually is a rather narrow field. He must know the principles relating to his technical processes—but this he takes from his handbooks with sufficient skill and assurance to meet the needs of his employment. His sphere is the devising and operation of the mechanism and the process to insure results with given points of departure and arrival.

3 The engineer may be thought of as an older head, figuratively speaking, whose function is to take the process of the technologist and put it to work efficiently. To recapitulate, the scientist discovers the new principles, the technologist applies them, and the engineer makes the technology pay dividends.

The trouble with this pretty picture is that it is all too simple. The members of any category are ever refusing to stay put. (Even cavalry horses ride in trucks nowadays.) These indistinct boundaries are the cause of much of the uncertainty surrounding engineering education today. A noted mining engineer recently complained that the electrical technologists in one of the big central stations had done a poor job of engineering; they had cut down the coal consumption at too great a capital charge.

Lest engineering educators fall into the danger of smugness they must recognize a tendency to overconservatism. Much has been said by competent authorities—not all of it to be accepted as incontrovertible—against the seeming narrowness of technical education today. For example, the exclusion of so-called "cultural" subjects from engineering is decried and the plea that engineering is a culture is not too convincing in this

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argument. We find two hostile camps today. In one, the engineers who look with disdain on the crowd of armchair philosophers and in the other, the humanists who in turn scoff at the engineers' stolid mien. This is all wittily set off by Doan:[1]

Almost all of us would agree that this realistic approach to social and individual problems is desirable. There is, however, a class which continually mistrusts the engineering approach and that is one which includes the lawyers and economists. They are, as Professor Thurman Arnold of Yale calls them, the "high priests" of our present social cult, the ones who argue in vague terms about abstract ideals and "isms" instead of coming to grips with the obvious needs of our country today to improve conditions on the farm, in the factory, and in the home. This group criticizes the engineer as one who seeks to "rigidify" any system or problem which he examines. We exclude all human and emotional factors from our calculations in social problems, they say, and strive to fit the situation into a concrete equation by excluding all non-quantitative factors, and then proceed to solve this equation and apply the solution to the group concerned as if they were guinea pigs.

The economists and lawyers do not realize that they themselves attempt to rigidify the recent past into a set of convenient generalizations, called economic and legal "principles," likewise rejecting any forces which do not fit into their theories, and then attempt to judge the present and predict the future on the basis of these selected and rigidified theories. The reason so many economists have been wrong in their predictions is that they too love to simplify their pictures by neglecting those facts that do not fit, such as "politics" and technological "developments." That is why their predictions during the early years of the depression were so universally wrong.

After all, it matters little if the problem is attacked by economists or by sociologists with thorough training in engineering methods of thought, or whether our engineers must be very thoroughly grounded in the human-relationship studies.

TREND TOWARD POSTGRADUATE EDUCATION

Another generalization, which may be questioned by some but seems safe as representing the major tendency, is the trend toward more graduate work for the development of research workers. One may find numerous examples of research work in engineering education—called "experimentation" decades ago. However, the pursuit of graduate studies was the exception rather than the rule and, as a matter of fact, still properly is not practiced by the majority of engineering students—in fact some branches of engineering are more restricted in respect to graduate work than are others. Chemical-engineering graduates are more prone to take graduate work than are, say, civil, or mechanical, or mining engineers. The same holds true for electrical engineers—and this comparison is not to be thought of as being invidious in any sense. The greater flexibility, or freedom for innovation, permitted to those in the practice of chemical engineering as contrasted with civil engineering is obvious.

This situation was crudely expressed by a friend of mine not very long ago. He said something like this: "The civil engineer has less latitude for his fancy; he must run his train on the floor of the bridge and not on the ceiling. On the other hand, if the chemical engineer cannot run his train on the floor he dumps in a catalyst, raises the temperature and pressure, and runs it upside down on the ceiling!" The almost endless combination of components open to the chemist give him a latitude which apparently makes the opportunity of the civil engineer seem quite limited in comparison. However, the thought is offered that "there's gold in them thar hills," and by virtue of more recognition being given to research, some of the branches of engineering might well profit by the experiences of the electricals and a few others. Admiral Bone of the U.S. Navy remarked several years ago that the Navy felt it knew practically nothing about steam. This, of course, was not meant to be taken literally but is indicative of the unexplored horizons yet to be found in all directions.

Commercialization of the utilization of fuels by hydrogenation or the water-gas reaction offers attractive prospects about which not all is yet known. The mining engineer could well study generation of energy at the mine or even in the coal measure itself. The regarding of natural gas almost exclusively as a fuel rather than a chemical resource, philosophically at least, plumbs the depths of wasteful shortsightedness. One of the most needed activities today is the systematic study of structural design by our structural engineers; a good start has been made in this field by certain manufacturers of lightweight transportation equipment, but the questions need to be taken further from the realm of empiricism and the whole matter put on a rational basis.

One very helpful sign is the increasing strength of the graduate schools in our technical colleges. Progress in this area poses weighty questions for the engineering educator. For many years past, the position of the fundamentals versus specialization; the humanities versus more technical studies; three-, five-, or six-year curricula versus the usual four-year, and other matters have been considered from all angles, but seemingly have yet to be decided. It is impossible to take time to develop these discussions here; the engineering educator must beware that he does not become frozen in his views on the scope and content of curricula. It may be that the war crisis will result in changes in higher education which we do not visualize at this moment.

IMPACT OF THE WAR

Looking to the future and what the impact of the war may likely be on engineering education: First we must and shall win. Some argue that we must police the world for a long time following the conclusion of hostilities, if what follows may not be called a "peace." Others doubt that we will be called to this high destiny in view of our own performance since 1918. No matter what our economic situation may be, one or two generalizations seem safe as likely tendencies. One may visualize a stimulation of interest by the public in engineering education for the remainder of the war and for a long time following.

We know that at present many students coming to colleges of engineering are not prepared one way or another for the profession and this is evidenced in our mortality rate. We also know that there is a large reservoir of potential engineering students which might be tapped to siphon off the youth with natural aptitudes for technical work on one level or another. We know that economic barriers alone now prevent many of our most promising youth from entering our technical schools and as a war measure, at least, there may be some remedial legislation in the near future.

The "training for life" about which there has been so much prating in some quarters is a rather broken reed when it is recognized that much of what it has produced is little more than carping criticism. Interest in mathematics and science should and must be restored since, as one of the A.S.M.E. presidents pointed out several years ago, none of us wants "to go back and live in a hillside with bugs in his hair." Technology, however, will not save our souls and engineering education will have to be made reasonable with a leavening of sociology, economics, and religion, if you will.

[1] See *Journal of Engineering Education*, vol. 29, no. 4.

CO-OPERATIVE EDUCATION

An Answer for American Industry

By MARK ELLINGSON

PRESIDENT, ROCHESTER ATHENAEUM AND MECHANICS INSTITUTE, ROCHESTER, N. Y.

I AM very happy to speak before you today because you, the engineers and technical men of America, are the men of the hour. Through technological advances you have put into motion many of the great forces of the world today. Upon you depends the outcome of the war; and after the war is over and we have emerged victorious because of the contributions of our technical society, the outcome of the peace in turn will rest upon the shoulders of the men who operate our productive system. I am confident that American ingenuity and skill will bring us through successfully in all these endeavors.

WHAT WE ARE FIGHTING FOR

Let us consider, for a few minutes, what we are fighting for. We, the people of America, are fighting for "the American Way of Life." We are sending our sons into the Air Force, into the Navy and the Army and the Marines. We are waging total production in our factories to support them. We are willingly depriving ourselves of peacetime luxuries so that all our effort and all our resources may go into the battle. But what is this American Way of Life? It is a standard of living so far superior to that of any other country in the world that the great masses of people everywhere are insisting upon getting it for themselves. It is all the things you and I accept as natural results of honest work, but which other peoples cannot achieve through work. Clean attractive homes with electricity, refrigeration, oil heat, and a radio, set in an attractive bit of lawn and garden miles away from the place where we work. An automobile to take us freely back and forth to our work whenever we wish to go and to take our families wherever they want to go. I would add to the four famous freedoms a fifth—freedom of action—for that is what the creators of machines have given to the American family. Every mechanical device created has freed our fellow American of hours of labor that once tied him to the job of sustaining life for himself and his family. Engineers and technicians have given us this fifth freedom—freedom of action—which is an important ingredient of the American spirit for they have lifted all of us who were not born with a silver spoon in our mouth from drudgery. We have become masters of great sources of energy that do our bidding with the pushing of a button. With freedom of action the energies have brought dignity into the home of every American who works hard to achieve it. This is the standard of living that the peoples of the world envy.

Let us look back once more. Upon what is this standard of living based? It is based upon the deep American conviction of the worth of each individual translated into industrial organization which makes the tools of freedom of action available to every worker. Inventive genius creates the mechanical servants of the American way of life. Industrial management and organization make it possible to produce them in enormous numbers. Advertising displays their possibilities to everyone who wants them. Work and wages makes it possible for the individual consumer to own them. It is a highly co-operative effort making it possible for everyone to benefit by the genius and organizing ability of his fellow countrymen if he is able and competent in some field associated with the common effort.

EDUCATION FOR COMPETENCE

It is upon this subject of competence, and education for competence, that I wish to speak. The current war has brought to a head a situation which has long been critical in both industry and education. I propose therefore that both industrialists and educators re-examine the relationship existing between education and industry. I have endeavored to show you that I believe the active expression of our American way of life is made through the tools of living that industry has produced. The automobiles, the telephones, eyeglasses, the surgical instruments, the cameras, the central heating plants, and the hot-water heaters. Think of all these things in terms of the dignity they have added to your life. Then we can appreciate the importance of the industrial job each of you is doing. Upon your competence and the energy with which you display it rests the future of America. You create the way of life we wish to return to after the war. In this grim time you create the tools of our protection. Yet I believe this is a fact that American educators have, until now, failed to understand.

The tremendous demand for man power on the part of productive industry has brought with it its corollary need for more technical training. The successful prosecution of the war demands not only a well-trained army but a well-trained industrial structure which is fundamentally a technological one. Industry and education must work together to train men who can become technologically competent to assume their share of the work of both defense and aggression. Where educators have failed to foresee the importance of developing programs of technological training, they are in these critical times reaping the unhappy harvest of their mistake in the present dwindling of the size of student bodies. But where industry and education are working together toward the common goal of competence there is a solution to the problem.

There is, of course, no single plan whereby these goals can be accomplished, but in co-operative education we have a plan so closely geared to the needs of the individual and of the economic structure that we ought to concern ourselves with its expansion and improvement. There are two basic assumptions underlying co-operative education. The first is that work experience shall be given to the individual student for the sheer educative value to him. The boy who goes into an industrial concern on a co-operative job is learning the way of life of the twentieth century just as the boy who worked in his father's fields or shop or store learned the way of life of the century that is past.

I have long adhered to the belief that every minister, every teacher, every doctor, every social worker ought to have practical experience in factory work so that they might see at first hand the operation of our productive system. I am sure that our

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sermons, our social work, and our teaching would all be improved from this contact with reality.

The second assumption is that co-operative work shall be given to the student to help develop technical competence. Schools like Antioch College, which was among the early institutions to develop the system of co-operative work experience, thought only in terms of work. A young pre-medical student might be sent into a factory for the months that he worked away from school. This was of value. He learned the habits of work and he broadened his experience, but he did not increase his own competence in the job he was preparing himself to do in the world. My own institution requires that the student work for alternate four-week periods in school and in an industrial job closely related with the subjects of his study in school. Thus the boy who is studying photographic technology in school works in an industry producing cameras and photographic equipment, and the machine-tool maker works in an industry producing machine tools. His work experience and his school experience are closely correlated, and he is under constant supervision both at school and on the job so that he may be guided in receiving the greatest benefit from the total experience. The educational institution attempts to help him, as an individual, develop his own personality as a competent citizen and a competent worker in the industrial life of his community.

As one examines the status of co-operative education in the United States it is amazing to learn how few institutions have developed co-operative programs. Antioch, Cincinnati, the General Motors School, and a few others have moved in this direction. I have come to the conclusion that the schools of this country must assume the responsibility for creating more of these opportunities. The active steps toward achieving this purpose are those that have been used by the Rochester Athenaeum and Mechanics Institute in setting up the program it is now carrying on. They are: (1) discovering the needs that exist in industry and (2) working out programs in the school to meet the industrial needs. It is only in this realistic way that any program of co-operative technological education can be developed. I submit to you that co-operative education stands or falls on the degree to which education co-operates with industry. Let me cite specific illustrations of techniques that have already demonstrated their usefulness in the institution which I represent.

HOW THE CO-OPERATIVE PLAN WORKS

The Rochester Athenaeum and Mechanics Institute is a privately endowed, non-profit-making technical institute operating at the post-high-school level. The co-operative program is carried on in the mechanical, electrical, chemical, photographic, retailing, and food-administration departments. As I have pointed out, students normally spend four weeks in school and four weeks in jobs closely related to their occupational goals.

Only those kinds of employment which have a direct bearing on the vocational goals of the students are regarded as co-operative. Students are placed in jobs only where they receive the same wage as other beginning workers; this requirement is basic to the Institute philosophy, as it is believed that one of the major advantages of co-operative work is the feeling of status which accrues to the student as he assumes a place as a productive worker. During the school year 1940–1941 more than six hundred students obtained work experiences, and their earnings varied from eight dollars a week with maintenance to twenty-two dollars a week without maintenance. Although the money received for the co-operative work is of great assistance to students with limited finances, the principal objective of the work experiences is to provide a catalyst in synthesizing and integrating theoretical and practical experiences.

The department heads, who are also responsible for counseling students in their departments, make contacts with industries for the purpose of obtaining co-operative jobs and select those individuals who are to be sent out for interviews. Because of the administrative setup of the Institute the relation between the student and the counselor is extremely close. Counselors have at their command a "behavior journal" which brings together the results of classification examinations, incidents of student behavior noted by faculty members, summaries of conferences held with students, and periodic syntheses of individual adjustments and personal needs as revealed by the continuous picture obtained from the journal. With this body of information counselors are able to select students for certain industries and jobs which will be most beneficial to the students' total educational programs. Although personnel men in industry actually do the hiring of the students, weight is given to the suggestions made by counselors.

Rochester industries and businesses co-operating with the Institute look on all students as promotional material and normally arrange a sequence of jobs so that each student has the opportunity to make a special study of the processes in a plant or of the activities in a retail store. The Institute curricula have likewise been constructed from activity analyses, and each student is trained, not for unit trade skill but for proficiency in a cluster of jobs within his chosen occupational field. Co-ordination of theory and practice is thus obtained as the student works on jobs within his chosen field and studies from manuals based on analyses of duties, skills, and attitudes exhibited by successful workers.

Follow-up studies which have been made of graduates indicate that co-operative education contributes very effectively to the student, the industries, and the community. For example, a study of 403 men who have graduated from the electrical department during 1925–1939, inclusive, reveals that 96.7 per cent were employed and that of those employed, 77.3 per cent remained in the field for which they were trained. This latter percentage is significantly higher than the 69.8 per cent reported in an older study, which extends over a comparable period of time and which analyzes graduates of technical institutes not offering co-operative courses. It would appear from this that co-operative work provides an orientation to the vocational world which assists individuals while in school to clarify their occupational goals and to establish contacts leading to permanent employment upon graduation.

The value of this type of education to industries is evidenced not only by their willingness to continue the relationship but also by the fact that, of the 337 electrical-department graduates accepted as trainees by co-operative companies, 44.8 per cent remained with the firms with which they had been co-operatively employed and 19.6 per cent were employed by other co-operative companies. Thus 64.4 per cent of the students who had held co-operative jobs remained with co-operative companies. Obviously a type of education which provides promotional material to industries and reduces the employee turnover of those inducted by this method to 35.6 per cent (100.0—64.4) over a fifteen-year period is looked on with interest and satisfaction by industrial leaders of the community.

The value of co-operative education to the community is evidenced in part by the satisfactory occupational adjustment already mentioned and by the ever-increasing number of graduates who are assuming positions as contributing citizens in their own communities.

THE PART PLAYED BY INDUSTRY

Thus far I have discussed primarily the responsibility that the school has to industry, but this is a joint responsibility and industry itself must be prepared to work out a well-organized and

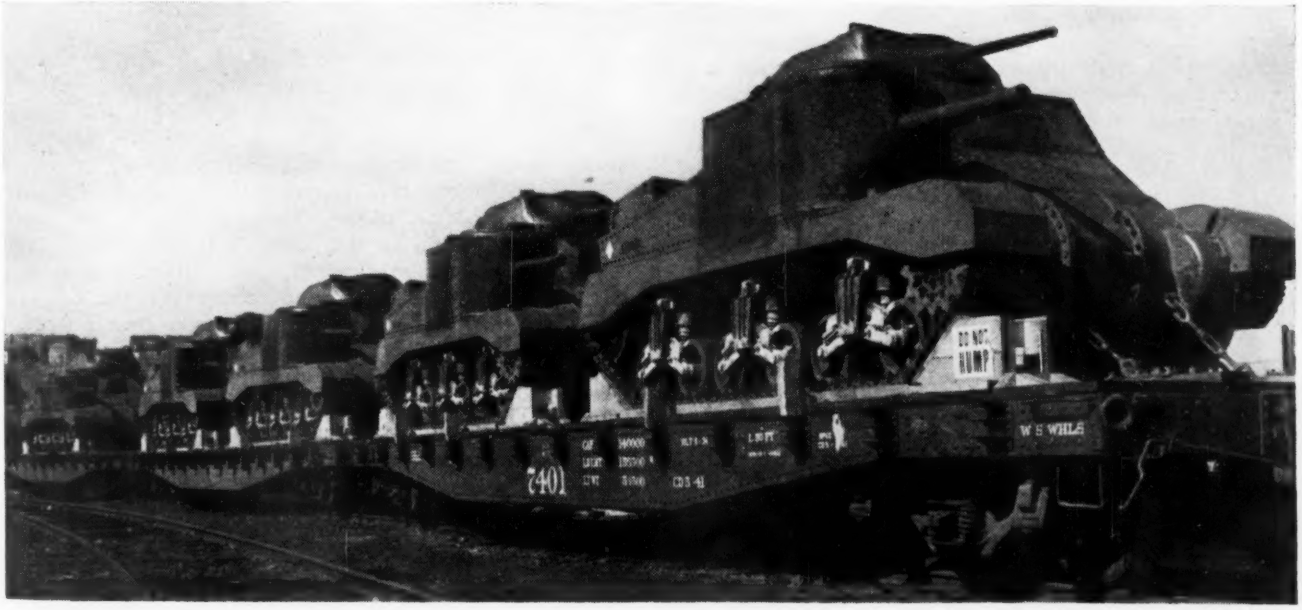
co-ordinated program of co-operative work if it is to secure optimum benefit from the co-operative system. For example, one company in Rochester makes it a practice to place co-operative students on different jobs thoughout the plant on each of the four-week periods. Thus a student completing the three-year course will have had an opportunity to work in fifteen different divisions of that organization. By that time he has had an opportuntity to try his talents in many ways. This same organization prepares a series of specific questions, the answers to which must be found by the students in their sojourn of four weeks in the department involved. When plans of this kind are carried out there can be no question about the success of co-operative education.

Still another organization in accepting co-operative students for employment arranges a schedule of work experience that gives the student contact with all parts of a single department with the expectation that somewhere within the group he will be able to make his optimum contribution. In both of these cases the school itself is responsible for the preparation of a specific series of co-operative assignments which tend to tie together work of the school and work of the industrial plant. There is an individual designated as a co-ordinator whose function is to see that relationships between school and industry are kept healthy.

Observers of the results of the war effort in England tell us that a new spirit and a new type of leadership is developing with the increased understanding of the importance of the industrial worker. The importance of competence, the importance of industrial management, the importance of a kind of self-governing habit in industry is becoming evident. We are making strides toward this spirit in this country wherever there is emphasis placed on industrial management. In Rochester we are giving courses in industrial management to thousands of men from the industries in our evening-school classes. In this way we are developing competence and the techniques of co-operation at the same time. It is too early now to predict what effects these efforts will have upon the peace that is to follow the war. However, I venture to say that there is nothing more important to the health of the peacetime America that we hope to live in than a strong productive system. Standards of living remain high when the system produces much and each individual shares in accordance with what he has contributed. I am profoundly convinced that we have not scratched the surface with respect to providing people with the things they want. In the future we are going to have more education of the type I have described to you. Industry is going to assume greater responsibility for it. I look forward to a time when no individual will reach the age of 20 years without having had some kind of work experience. Education takes place within the individual in work experiences, in classroom studies in contacts with other people, and in the social and civic life of the community. All of these things influence the student and, to some extent, determine the kind of individual he is. Because this is true, it is difficult for me to see how we can split education into general and occupational categories. We hear much from the liberal-arts colleges to the effect that every individual ought to have a good liberal education before being concerned with occupation. I would like to point out that I have seen insight and understanding come to an individual as a result of work in a factory. It is not enough that an individual be taught to think about abstract things. He must be taught to use his thinking process on the problems that confront him day by day and to utilize sound techniques in arriving at a satisfactory solution of the problems confronting him. Thinking must be tied in with action.

I well remember the childhood admonition: "Hell is the place that is paved with good intentions." Too much thinking and too little doing can often lead us into a kind of paralysis of the active creative parts of our being. I know that a man who has learned to do one job well takes added ability to the next job he attacks, and even though he may change his mind after he has studied photography, he will carry much that is valuable to him from his old job into his new one. This is a basic strength of co-operative education.

In closing, let me repeat that the winning of both the war and the peace depend upon a sound technological structure. If we are to develop an increased flow of man power into these important channels, we must examine the way in which co-operative education tends to educate for competence. This is a joint responsibility of both education and industry and one in which we must not fail.



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A FREIGHT GETS THE RIGHT OF WAY

The OUTLOOK *for* ADULT EDUCATION

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ANY discussion of the outlook for adult education needs to start with a definition. The term "adult education" is applied to almost every conceivable form of education—individual or group—that may be pursued on a part-time basis. It is used for such widely differing mediums of education as public-lecture series, garden clubs, or sets of phonograph records of musical compositions, as well as for organized programs of postgraduate work. There are a great many more people who think of adult education as a broad means of social advancement than there are those who think of it in terms of organized programs of technical or professional training.

For present purposes it would be inappropriate to attempt any treatment of the general features of such a complex, varied, and extensive field of endeavor as is adult education as a whole. These remarks will relate, therefore, simply to adult technological education or, still more narrowly, to such education for the specific needs of industry.

THREE TYPES OF TECHNOLOGICAL EDUCATION

In order to understand the relationship of adult technological education to engineering education at large in this country we should first consider briefly the several component parts of the latter.

These include (1) vocational education which is provided chiefly for students of high-school age. It is into this field of technical training that federal and state funds have been poured in recent years through the appropriations of the Smith-Hughes and George-Deen acts. Whatever the quality of the work may be, educational programs of this type have certainly grown rapidly in volume in all parts of the country. Generous financial support has been given to it, numbers of schools have increased rapidly, state departments of public instruction as well as the federal government have promoted it, and there seems, in short, to be little need for concern about its future—except possibly as to the quality and purposes of some of the work which is conducted in this general field. It must be recognized that during the present emergency this type of the work seems to be serving a very necessary and useful purpose.

2 At the college level also, provisions for technological education seem to be ample, at least for peacetime conditions. Engineering curriculums are offered by approximately 166 degree-conferring colleges and universities, and the quality of their work seems to be very satisfactory, though the institutions operate under the handicap of attempting to prepare men for a very wide range of industrial pursuit by means of a single type of program. It has been said in relation to higher technological education in this country that we have put all our eggs in one basket, and I believe this to be a correct characterization. This one type of undergraduate engineering curriculum is virtually the sole agency of preparation for the whole range of activities above the level of the high school. It is a fact which we must admit that employers frequently seek engineering-college graduates for positions which do not really require training as extensive as that provided by a professional engineering curriculum; shorter and more practical types of educational programs would be fully adequate to meet their needs. Students attracted to engineering colleges include a very wide range of high-school graduates, and the record of failures—60 per cent during the four years—is striking testimony to the fact that the heterogeneous college populations are not in keeping with the rather highly scientific and technical curriculums engineering colleges offer.

However unfortunate it may be that the engineering college, with a relatively small number of conspicuous exceptions, is the sole agency of higher technological education in this country, it seems clear that during ordinary times there is ample provision for training men for the higher technical pursuits of industry.

3 The great need in relation to technical training at large in this country, as has been said repeatedly, is for a form of program intermediate between the vocational school and the engineering college. Time does not permit a recital of all the evidence there is to support this belief and it may merely be said that there is a great deal of factual data and of testimony to support it.

FAILURE OF TECHNICAL EDUCATION AT INTERMEDIATE LEVEL

The story of the intermediate levels of technical education in the United States, however, is an almost continuous story of the diversion of educational foundations from the types of programs they were originally intended to supply to those of college type. Simply to run over the list of institutions—Carnegie Institute of Technology, Pratt Institute, Drexel Institute, certain divisions of a number of land-grant colleges, and others—will give a conception of this trend. It is a story of a losing battle between the foundations as established with their original aims and objectives in relation to the clear needs of industry, on the one hand, and of the eventual reactions of the general public toward them on the other. I think it was Wendell Phillips who said that if every American child could be awarded the bachelor's degree at birth the interests of higher education would be greatly advanced. There is more than a facetious merit in this statement, for it is the well-nigh universal belief of American parents that any form of higher education short of the degree program is not to be regarded as satisfactory for their sons and daughters; every American child must have the same educational opportunity, as does every other child, regardless of the needs of the nation and regardless also of inherent differences of abilities. It is this that is at the bottom of a good deal of the lack of correspondence between programs of technical training, on the one hand, and of industrial pursuits on the other. And it is for this reason that virtually our whole system of full-time education above the secondary level has been thrown into the same pattern. This attitude of the American

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public is also responsible for the fact that we are now tending to extend the general phases of college education to higher and higher age levels.

TWO REMEDIES IN SIGHT

But two remedies for this situation seem to be in sight (it will be noted that I use the word "remedies" as if a correction were needed, and that is my belief): One is through the agency of the publicly supported junior college and the other through programs of adult technical education. There is a third that I wish I might name as a possibility, the technical school operated by and in support of particular industries for the benefit of the young people of their communities who do not have and never will have the opportunity to pursue an educational program above the secondary-school level.

Thus far there is only one region of the country, so far as I am aware, in which the publicly supported junior college has developed successfully, and on a large scale, the type of technological program I am here discussing—that is, one of practical nature, of terminal type, and of briefer duration than that of the conventional engineering college. This region is California. In that state there has been striking success in the development of the intermediate type of technological training within the past decade or two. It remains to be seen whether this highly desirable trend will continue or whether it will go the route of other such movements and wind up in multiplication of the number of senior engineering colleges. And it remains also to be seen whether it will spread to other parts of the country. Let us hope that it will, for industry and the nation at large are in need of a considerable expansion of educational programs of this type.

The other means of developing the kind of training programs for industry I am discussing, and it is this with which we are here concerned, is through adult technical education. Here, I think, we are on safe ground in believing that conditions favor a considerable expansion of technological education. It is not only the great expansion of this type of training that has occurred during the present war, though this is significant, but it is also the possibilities that exist in extension programs during peacetime that prompt this belief.

NEED FOR ADULT EDUCATION SHOWN BY WAR

If this war is showing us any one thing about technical training, it is the great need that exists for briefer and more practical types of programs than the conventional engineering-college curriculum. The success that is attending the offering of such programs on a part-time or "adult" basis is one of the most striking educational developments of the whole history of technological education in this country. During the fiscal year ending June 30, 1942, not fewer than 300,000 students will have been enrolled in short, intensive programs of engineering study of college type. Some of these students will have been enrolled in more than a single program, of course, and a few of them will be pursuing such courses on a full-time basis. But over 90 per cent of them are employees of war industries or government departments who are attending classes out of regular business hours. The success and value of the Engineering, Science, and Management Defense Training program of the United States Office of Education, is attested very generally by the leaders of industry and government whom it has served. I think it is fair to say that this program has provided an indispensable source of men and women for technical occupations during the emergency. These programs have been instituted in response to a special and tremendous war need and by virtue of federal funds. And I venture to say that it will require continued public support—federal or state—if similar programs are to be kept in operation when the war emergency is over.

A very large fraction of this work has been given "in extension," that is, off the college campus. I believe it must continue to be conducted off the campus if it is to continue on anything approaching the scale that industry will require during the reconstruction era that will follow the war. By this it may be inferred that I believe a large program of retraining will be needed as we pass from wartime to peacetime objectives.

It is only by reason of the fact that this country possessed a large and effective system of engineering colleges that this war training program could have been undertaken. No other agency existed to conduct it, and none could have been created within the time limits that were imposed. In saying this I am not overlooking the vocational schools. The aims, purposes, and methods of the latter are so different from those required at the higher technical levels as to preclude the possibility of successful accomplishment of any such result as the colleges have produced. The significant fact is that it was the colleges which, through an extension and modification of their normal types of training, undertook this large increment to their regular programs when the need became apparent, when a definition of the type of work to be done was formulated in specific terms, and when funds were provided for conducting it.

AFTER THE WAR—WHAT?

It remains now, in looking ahead at the future of adult technological education, to judge whether we shall be able to continue to fill the gap in our general program of education for industry as we are filling it at present. I would say frankly that I have some doubt as to whether we shall continue to do so on a scale adequate to meet the needs of industry, though I hope my doubt may prove not to be well founded. Any traditional attitude of a people is very hard to change, and I fear that once the needs of war are no longer urgent we may slip back to the feeling that prevailed in higher education, as well as in the minds of the public, that it is only the curriculum that leads to a degree that deserves public support.

Possibly, however, and I sincerely hope that this may be the outcome, both industry and educational institutions alike may, from the example that the war has supplied, see not only the need for establishing a more varied system of technical education in this country, but also the practicability of supplying that need through part-time training programs. Some of this, and particularly in industrial centers, may be done through evening courses of briefer duration and more practical nature than the customary degree curriculum. A great deal of it will probably have to be done through extension classes set up by strong and stable institutions throughout the regions they serve. The lessons that have been learned during the present emergency as to how they should be administered and supervised, and the means of co-ordinating the programs with industrial needs, should be of the greatest possible benefit if such programs are to continue after the war.

One other important problem will have to be solved, the financial problem. It has been the experience of the present program that public financial support is essential. This was also the experience of some of the institutions that conducted programs of this type before the war. If public support is justified for technical training on a full-time basis, I can see no reason why it is not justified on a part-time basis. And I believe, therefore, that federal or state support should be made available for the type of training I am here discussing, just as it has been made available for Smith-Hughes and George-Deen types of training.

If it is made available, and if the educational institutions, the industries, and local communities will support educational programs of this type, I believe that great benefit will result to the program of technical training of this country as a whole.

VOCATIONAL EDUCATION *and the* WAR

By ALONZO G. GRACE

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IT IS difficult in these trying days to comment on the long-term implications of education and in particular on the trends affecting vocational education. Our first thought necessarily must be directed toward the adjustment of an educational system to meet the requirements of total war, that is, the training of a labor supply, development of health and physical-fitness program, translation of the war aims of the United States and the Allies into terms that can be understood by children and youth, the development of co-operative programs with the Army, the Navy, the Marine Corps, and Civil Aeronautics Authority, assistance in rationing procedures, enlightenment of the public with respect to the meaning of basic economic concepts (inflation) and a multitude of essential wartime activities.

One of Hitler's most powerful weapons is no secret weapon. His is an organization of a nation's youth—the mobilization of youth and its enthusiasm behind the supreme nationalist aim to restore the strength of Germany and to establish the Socialist State universally. Nazi organizations such as the "Jungvolk" (young folk), Hitler "Jugend" (Hitler youth), and "Bund deutscher Maedel" (league of German girls) take in hand youngsters from the ages of 10 to 18. In the youth organizations these recruits are raised on Nazi propaganda and a thorough physical-fitness program. They are encouraged to become enthusiastic about sports such as glider flying, model-airplane building, marksmanship, and the elementary principles of seamanship. They wear uniforms, go on long hikes, and learn to live in the open air. The first procedure in the totalitarian state has been a drastic reorganization of the educational system to provide the kind of members desired for the ultimate purpose of the state.

The American educational system is based upon a totally different idea. The control of educational opportunity in this country is not centralized. The educational system is organized on a local basis, for in the United States the community is regarded as the cell of democracy. The importance of local initiative and responsibility is a matter not to be regarded lightly as we face the future. Through state leadership service, research, and planning, with Federal financial assistance and leadership, and with local willingness to provide adjustments, a more effective educational opportunity is on the horizon.

With the understanding that the American school and college system is geared into the war effort, permit me then to turn to (1) some reasons for educational lag, (2) important trends affecting the future of vocational education, and (3) some of the needs in the field of education generally.

SOME REASONS FOR EDUCATIONAL LAG

The school has been criticized for failure to produce a nation of skilled workers; for developing false ideals concerning the ultimate objective of living; for failure to develop good work habits in youth; and for many other reasons. It has become common practice to attribute many of our present difficulties to a faulty educational system. Granted that America has an unwieldy and ineffective system of local administrative organization; that many state departments of education do not exhibit inspiring leadership, acceptable scholarship, pertinent research or effective service; that educators have been slow to face realistically the problems of youth; that the secondary-school program has been unduly academic in nature; that the school program is a series of unrelated compartments; that these and many other criticisms of public education are just and valid—the remedy does not lie in the creation of other agencies to secure the needed changes.

The best method of improving the school system and the best guarantee that the emerging product will represent social competency is the willingness of all elements to aid the existing educational system to do the job and to lend every aid to the end that the school system may perform the functions for which it was created. This is a major issue at the moment and no doubt will continue to challenge the disposition and vision of all concerned for some time to come.

There can be but one system of public education in this country and that system should continue, as it has for over 300 years, to be a responsibility of the several states which with few exceptions delegate the actual conduct of the schools to the people of the state through local boards of education. The solution to our problem does not lie in a superstate or superfederal government that will absorb the functions of units closer to the people. While it may be admitted that many units of local government conceived during the pioneer era in the evolution of American democracy no longer are able independently and separately to provide all the services now required for the security of the people, the solution does not lie in the creation of or transfer to units far removed from the grass roots. Without the sustained interest of the governed, efficient administration and effective establishment of policy can be only partially attained.

Instead of attempting to place the responsibility for failure to avert many of our problems, our thoughts must be turned to the development of a constructive program. It is essential, therefore, that every state undertake the appraisal and evaluation of its own school system and that the wisdom and intelligence of its citizens and professional educators be used to the maximum in the development of a program that will teach people how to live as well as how to make a living.

Whatever be the lag in public education it must be said that educators have not been wholly responsible. What, then, are some of the factors involved? The following considerations illustrate the complexity of the problem:

1 *Comparative Costs*. It is cheaper in terms of dollars and cents for a school system to employ a teacher for 40 pupils in an academic course than it is to provide one teacher for 15 boys or girls who desire to learn a trade or to learn how to make a living.

2 *Parental Desire*. Many parents struggle through life in order that their children may not have to endure the hardship,

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the sacrifice, or unpleasantness that circumscribed their lives. False values have been placed on certain types of training.

3 *Prestige Value*. There is a prestige value attached to the college-preparatory curriculum that impedes the real job of education. The real weakness in public education emanates from the prevailing belief that other educational opportunities are devices designed to take care of those who indicate a lack of interest or who fail in the college-preparatory curriculum. If we would build a classless society the social prestige attached to specific curriculums must be eliminated.

4 *Diplomas, Certificates, Degrees*. Business and industry have made the diploma from high school or college a prerequisite for employment. So long as those who employ regard the diploma of graduation as an index of competency, just so long will individuals fail to meet the requirements for employment. The criteria for employment should be "What can you do?" and "How well can you do it?" not, "What kind of a diploma do you have?" and "Where did you get it?"

5 *Sacrifice and Work*. It is essential that the American people as a whole begin to feel a sense of sacrifice for the welfare of our country. Let us not believe that we can live without enduring hardships or that we can ease our way out of the trying situations confronting us. The utmost sacrifice will be necessary in the years to come if this nation survive. Equal respect for all kinds of labor, physical and mental, honestly done, is recommended, but social barriers against the hand workers are set up. The office worker, for no good reason, is placed on a higher social level. This tendency must be corrected if there be a change in the school organization and curriculum. The best way would be to make honest statements concerning the qualifications of graduates.

We should be under no illusion concerning the training of the citizens of tomorrow. Vocational education and guidance do not create jobs. The proper diagnosis of the talents of the individual and the ability to ascertain those areas in which he can make the greatest contribution to his own happiness and to the security of society will at least give one a passport to a job. Training for the work of the world and for the work that each one is able best to do is the first essential in social security and the defense of a nation.

TRENDS AFFECTING VOCATIONAL EDUCATION

We cannot rest on the accomplishments of the past generation, in view of the conditions that will confront us during the next generation. Neither can we rest on the magnificent work of the present in the training of a labor supply for wartime industries. The accomplishments with respect to the broadening of the vocational program throughout America during this past generation, I believe, are evident. We must secure a balance in our educational program that does not now prevail.

We are confronted with the need for continuous planning and action. There are evidences on the horizon toward which we must turn if we are to be guided in the proper direction. The factors which will affect vocational education in the future are (1) a decline in school enrollment; (2) the breakdown of the skilled trades into a series of jobs; (3) the rapidly expanding apprenticeship program; (4) the mass production of operators; (5) the training-within-industry program of the War Production Board.

School Enrollment Decline. The statistical data on school enrollment have a distinct bearing on the future of vocational education. Frequently the objective of educational institutions may not be directed toward the welfare of the individual so much as toward protecting an enrollment. A qualitative criterion as the basis for operation has not been adopted generally. The facts revealed by the most recent available school enrollments are indicative of some of the problems. The following data illustrate the importance of the trend:

1 The total enrollment in our public schools in 1928 was 25,179,696. The peak enrollment, in 1934, was 26,434,193 pupils enrolled in public schools. A consistent decline has prevailed during the last 8 years.

2 The elementary-school enrollment in 1928 was 21,268,417. This has declined in 10 years to 19,748,174, or 7 per cent.

3 High-school enrollment in 1928 was 3,911,275. It increased consistently to 6,226,934 in 1938, the peak year.

4 The enrollment in our first grade reached its peak with 4,171,037 in 1928. There was a consistent decline in the next 10 years. Almost 900,000 boys and girls who should have been in the first grade, if the trend of 1928 had continued, are not there.

5 In 1918, 285,047 high-school and 27,915 college students graduated from their respective courses. Twenty years later there were 1,120,079 high-school graduates and 164,943 college graduates.

6 In 1870, there were only 16,000 graduates from high school out of 8,015,000 youths 17 years of age and over. In 1938, almost 46 out of every 100 youths 17 years of age graduated from high school. Of 2,458,000 youths 17 years of age 1,120,079 graduated.

7 There was in this country in 1938 a total of 21,049,000 boys and girls 5 to 13 years of age. Five years hence this group of 21,000,000 boys and girls will be 10 to 23 years of age. These are the youth who ultimately will determine the policies of this country.

The importance of these factors in the development of an educational program cannot be ignored. It is important, therefore, that as we reappraise and evaluate American education a balance in our program be secured. There should be available to every boy and girl the opportunity to ascertain his fitness for occupations; an opportunity to learn about the industrial and business resources of the country; how to use his hands and his talents to the maximum; a balance in our highly academic procedure.

Breaking Down of Skilled Trades in the Job. The breaking down of the skilled trade into a series of jobs is no longer a matter of speculation. Because of the present crisis and America's past reluctance to train skilled workers; the desire on the part of many of our people to get out of anything that appears to be work; our failure to dignify work and for a variety of other reasons, vocational education has not been as respectable as completing a college-preparatory course, so called. It was evident early, through the former Office of Production Management that, where skilled employees were not obtainable, the engineer was called upon to reduce a given enterprise to a series of jobs in order to facilitate production. Thus much of the skilled work has been broken down into a series of operations suitably performed by semiskilled and, in many cases, unskilled operators. There are many implications here both for labor and management as well as for training institutions. Definitely, it is a trend which cannot be ignored by educators. A long-delayed apprenticeship program now is under way. This is a basic essential in a complete educational opportunity. We have been without vision in delaying the growth of an apprenticeship program. This opportunity should provide for close integration with vocational schools or vocational opportunities within industry.

Job Training Does Not Produce Skilled Workers. There need be little comment on the purpose of the current training course for operators. It is designed to produce a labor supply rapidly. It is an induction into industry. It obviously does not produce skilled craftsmen. Too many youth, however, are under the impression that they are trained machinists as a result of having

completed the work. This fact, together with exceedingly high wages for many youth who previously had earned little or had been on relief during the depression period, is producing a state of mind and an outlook with which there must be the utmost concern. Adjustments following the wartime effort will be extensive and severe.

SOME FUNDAMENTAL NEEDS

The transition in the secondary-school program will not be accomplished immediately. It is highly desirable that, as changes are made, full consideration be given to many important issues. The ability of all to think constructively and critically rather than to accept without thinking the pronouncements of those with special interests is fundamental in a democracy.

The security of democracy itself is contingent upon the practical ability of the people to devise ways and means whereby all who desire to work may be provided with that opportunity. Men who own property and who have jobs are not the easy victims of subversive movements or of panaceas for their deliverance from a life of fear, of want, unhappiness, joblessness, and lack of opportunity. Certain fundamental needs must be faced realistically. A few illustrations of such fundamentals will be presented.

Work Should Be a Part of Education. Obviously, few people are interested in returning to the black page of yesterday when children labored long and hard. However, in our zeal to protect youth from the maturing value of work we have practically made work itself a hazard. Certainly the labor market should not be overcrowded by immature youth and adolescents. But the opportunity for every boy and girl in a school system as part of his education to learn what hard work means—and that means manual labor, work with one's hands—must be reintroduced in our system. Work should be regarded as part of the educational program just as Latin, Mathematics, Social Science, or any other experience provided for the individual. In my judgment, with proper follow-up and supervision and recommendations from employers, it should receive credit on the high-school record and be accepted for college admission.

New Types of Colleges. It is obvious that the high-school program has been unduly academic in nature, though youth possess interest in other areas. Our colleges should provide admission based on the intellectual and social maturity of the individual and his capacity to read, write, and speak English. The procedure thus far is to gage the student's competency or his desirability for college on his rank in the high-school graduating class and his capacity to pass certain specified courses. Perhaps there is a difference between the institution that specializes in the production of scholars and the institution of higher education that is dealing with average people. Those who have been the early and easy victims of subversive movements in this country have been not only those without jobs and security but many with insufficient schooling to enable them to distinguish between the forfeiture of their liberty and and the panacea proposed for their deliverance. Too many youth fail in college; too many youth do not get to college because of economic inability of their parents. I believe then that a system of scholarships should be made available to youth who because of economic incapacity ordinarily would be denied a college education.

The Search for Talent. I hope sometime in this country we shall give scholarships or recognize the need for the development of ingenuity. Those who possess talent in any particular direction should be permitted to develop this talent to the utmost. I would hope therefore, for the recognition of a system of education that would help perpetuate the ingenuity that has made our country famous. This means substantially that children should be permitted to develop to their greatest potentiality irrespective of race, nationality, economic condition, political affiliation, or any of the irrelevant factors that sometimes determine the future of the individual. Approximately as many competent youth are denied admission to college because of economic disability as enter because of parental ability to supply the financial means.

Determination of Fundamentals. Our secondary-school program generally represents a wide offering. Those subjects in the curriculum that are no longer of any particular use to large numbers of individuals should be eliminated. Fundamental changes ultimately may reduce the need for different subjects. This is particularly true if areas of experience supplant the narrow subject-matter compartments. English, for example, should be taught as part of every course in the child's experience. The need for the specialist in speech, in reading, in the field of appreciation of literature is evident; also evidence of knowledge of arithmetic in high school.

Development of Marketable Skills and Aptitudes. The secondary school may develop in boys and girls marketable skills which will make employment much easier upon completion of the twelfth grade—or at such time as the individual may drop out of school. The further development of the program of arts and industries—beyond the present manual training or avocational approach; provision for review courses in arithmetic before leaving school; the concerted action of all teachers on such fundamentals as accuracy, neatness, thoroughness, ability to assume responsibility, willingness to follow directions, and many other qualities essential to employment may be made possible in the comprehensive secondary school.

The Socially Competent Individual. It must be realized too that in the development of social competency, the educational system as an institution or in co-operation with other institutions must provide sufficient opportunity in several areas of life experience for well-rounded development. Among the other areas are (*a*) home and family life; (*b*) the socioeconomic forces; (*c*) health; (*d*) ability to enjoy the aesthetic elements of life; (*e*) spiritual development of the individual; (*f*) natural environment; (*g*) training for work of the world with adequate provision for retraining opportunities.

These are trying times. It is altogether probable that many of the difficulties encountered during the period of the first World War may be repeated unless those in places of leadership are willing to face the situation realistically and without emotion. Plans must be well formulated. It is equally essential that there be recorded the almost universal desire on the part of our people for a better vocational opportunity for our youth. During ten years of a depression period, when many educators urged more vocational education and preparation for the days to come, few were willing to spend the additional sums to train the workers that ultimately were to be needed.

It seems to me that America should no longer hang its head or assume an inferiority complex, because our doctors no longer come from Vienna, our artists from Italy, our scholars from German or English universities. What have we to fear? It is in this country that the greatest inventive genius has developed. It is in this country that outstanding men of the medical profession, scientists, magnificent laboratories, tremendous research resources, and ingenuity, unsurpassed anywhere in the world, has evolved. We produce artists, musicians, skilled mechanics as well trained as anywhere in the world. We must provide greater opportunity for the discovery of talent. We must develop in our country an attitude toward work that will make graduation or completion of a vocational course as important as graduation from an adequate or college preparatory course.

Men and women become citizens of the United States and

(*Continued on page 675*)

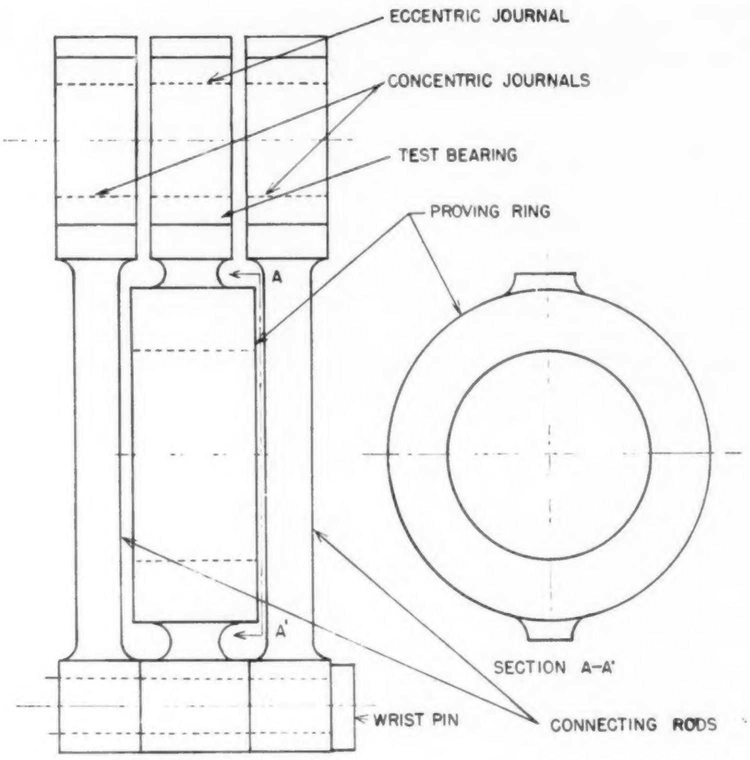

FIG. 1 METHOD OF APPLYING AND MEASURING LOAD ON TEST BEARING

Intermittently Loaded SLEEVE BEARINGS

By R. W. DAYTON,[1] J. G. LOWTHER,[2] and H. W. RUSSELL[1]

MANY reports have been made on investigations of the friction and seizure of steadily loaded sleeve bearings, but none to the authors' knowledge on the related case of intermittently loaded bearings, such as those in connecting rods. Since an important group of bearings are of the intermittently loaded type, it seems desirable to report the findings of a study of the subject, even though the investigation has been brief.

This study was a small part of an extensive study of failures in tin-base-babbitt bearings, and its purpose was that of determining whether babbitt was subject to serious failures when operated in the partial-film region of lubrication. Incidentally, data were obtained on friction in the fluid-film and partial-film regions of lubrication.

The essential features of the apparatus used were simple in design, as shown in Fig. 1. Three journals were keyed to a common shaft. The outer two were concentric with the shaft, while the bearings which operated against these shafts were held in connecting rods of normal design. The central journal was made eccentric by a predetermined amount in the range of 0.010 to 0.025 in., and the bearing which operated against this journal was held by a specially designed connecting rod in which the column of the rod was replaced by a proving ring of desired stiffness. Since the oil-film thickness would be only about 0.0001 in. during operation, it is apparent that changes of oil-film thickness would have little effect. In operation, the eccentric journal alternately compresses and elongates this proving ring and loads all three bearings. It is obvious that the central bearing carries the full load, and each of the outer two bearings, one half of the load. The actual load was determined by static measurements of the deflections of the previously calibrated proving ring at the two positions of maximum deflection.

All three connecting rods were fastened to a common wristpin. By supporting this wristpin by a spring scale through a dashpot to damp out cyclic-torque variations, the frictional torque could be determined with an accuracy of 2 in-oz. The coefficient of friction was calculated from such readings. The figure for the average load on all bearings throughout a cycle was used for these calculations.

Although it would have been somewhat more desirable, from the point of view of the friction studies, to load all bearings equally, a more complicated design would have been necessary to do so; and since the main consideration in this work was the study of any failures of the central bearing, such complication was deemed undesirable.

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[2] Ordnance Department, United States Army. Mem. A.S.M.E.

Tests were made at shaft speeds from 8 to 583 rpm, and maximum loads from 180 to 1560 psi. The bearings were lubricated from oil holes drilled in the journal on the low-pressure side from a heated sump at pressures of 40 to 45 psi gage. Oil temperatures from room temperature to 275 F were used. The oil was a commercial S.A.E. 30 crankcase lubricant, with a viscosity of 550 SSU at 100 F, 67.4 SSU at 210 F, and a viscosity index of 102.

Five tests were run, all on steel-backed bearings lined with a 0.020-in. layer of a babbitt containing 7.6 per cent Sb, 3.75 per cent Cu, 0.25 per cent Pb, balance Sn. The initial clearance varied from 0.001 to 0.002 in. The bearings were $2^3/_8$ in. OD, 2 in. ID, and $1^9/_{32}$ in. long. The bearings, which were not grooved, were complete sleeves to avoid the dimensional difficulties encountered with split bearings. The finishes of all journals and bearings were comparable to those of automotive practice.

A composite graph of friction against ZN/P, containing the friction data for all tests, is shown in Fig. 2. The friction in this graph was calculated from the total for all bearings; the ZN/P was based on the average pressure for all bearings. This graph shows that, in the fluid-film region of lubrication, the individual points fall nearly on the Petroff line and thus are in agreement with conventional theory for steadily loaded bearings.

Departure from fluid-film lubrication begins when ZN/P is less than 25, and this departure becomes large at values of ZN/P from 1 to 10, depending upon the finish of shaft and bearing and the amount of wearing-in. With well-worn-in bearings, departure from fluid-film lubrication is not serious except below a ZN/P of 5. (It should be remembered that the calculations of ZN/P are based upon the average load. Based upon the maximum load, serious departure is obtained only at ZN/P values of less than 2.) In usual automotive practice, ZN/P will be greater than 15 to 20, based upon the average load throughout a cycle, so no difficulties, owing to operation with partial-film lubrication, should be expected in service.

There were no failures of any of the bearings tested. Even when operated for long periods at high coefficients of friction (0.020–0.030) and values of ZN/P one third to one fourth of those in automotive service, no scoring occurred, and there were only minute (0.00002 in.) amounts of wear, as calculated from weight-loss measurements. The only visible change was the "shine" obtained on the bearings at the high load points.

CONCLUSIONS

It may be concluded from the information obtained from these tests that:

1 The friction of intermittently loaded bearings is approximately the same as that of steadily loaded bearings in the fluid-film region of lubrication.

2 Departure from the state of fluid-film lubrication occurs only under more severe conditions than are obtained in ordinary automotive service.

3 Babbitt bearings wear but slightly and do not score, even under conditions severe enough to cause large departures from fluid-film lubrication.

Acknowledgment is due the International Tin Research and Development Council for permission to publish this information.

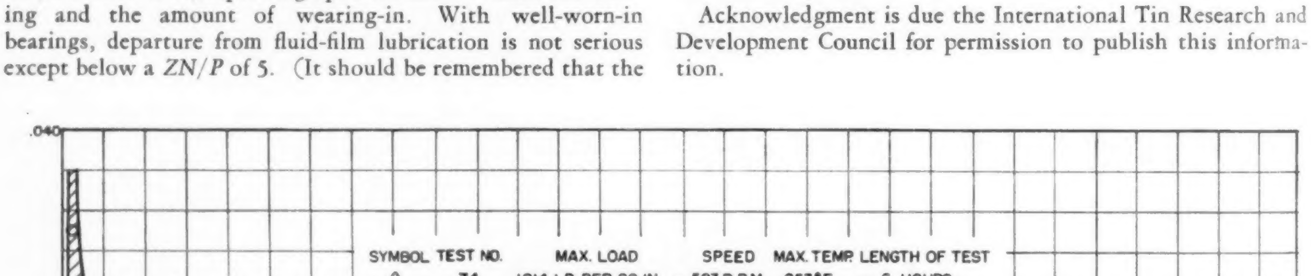

FIG. 2 FRICTION DATA FROM TESTS OF INTERMITTENTLY LOADED BEARING

POWER-PLANT PROBLEMS

Summary of Discussion of Ten Questions by A.S.M.E. Power Division

A ROUND-TABLE discussion of power-plant problems of current interest by power-plant operators, engineers, and equipment manufacturers, under the auspices of the A.S.M.E. Power Division, was a feature of the Semi-Annual Meeting of The American Society of Mechanical Engineers held at the Hotel Statler, Cleveland, Ohio, June 8–10, 1942. R. M. Van Duzer, Jr., engineer, production department of The Detroit Edison Company, acted as chairman. J. C. Hobbs, vice-president in charge of manufacturing, Diamond Alkali Co., Painesville, Ohio, was recorder and prepared the summary of the discussion, which is reported in what follows.

Discussion was contributed largely by members of a panel which had been picked in advance of the meeting and by other persons in the audience. Comprising the panel were: O. F. Campbell, Sinclair Refining Company (petroleum); F. M. Welsch, National Tube Company (steel industry); W. E. Caldwell, the Consolidated Edison Company of New York, Inc. (public utilities); E. G. Bailey, Babcock and Wilcox Company; John Van Brunt, Combustion Engineering Company; and A. C. Foster, Foster Wheeler Corporation (boiler manufacturers); C. H. Fellows, The Detroit Edison Company (chemical water treatment); B. E. Tate, Jr., National Cash Register Company (industrial plants); and G. B. Warren, General Electric Company; F. K. Fischer, Westinghouse Electric and Manufacturing Company; and C. C. Jordan, Allis-Chalmers Manufacturing Company (turbine manufacturers).

Ten questions relating to "power for war production" were discussed. The questions and Mr. Hobbs' summary of the discussion follow.

1 *What can be done to improve cleanliness of boiler surfaces, thereby lengthening the periods between shutdowns now required in most cases for hand cleaning?*

Chemical water treatment was recommended. Cleaning practice varies from turbining each time a boiler is out of service to, in a very few cases, intervals of a number of years. A case was cited in which sodium aluminate was used to change the character of the suspended matter so as to make it "flow" and be discharged to the blowdown. On external surfaces, one engineer advocated the careful selection of coal to prevent slagging while another emphasized the necessity for burning a wider range of coal because the best coal may not be available because of war conditions or, as in the Midwest, may not be economically available because of the location. Pooled coal supplies may be allocated.

Cleaning of the upper portion of the furnace walls materially improves the condition of the boiler tubes proper by lowering the temperature of the gases entering the tube bank.

Fineness of pulverization and the amount of excess air are also related to external cleanliness of tubes. Access doors for hand cleaning should be provided wherever necessary.

When improvements are made and rating is raised, more slag trouble results and more improvements must be made.

Oil-refinery sludge sometimes carries high percentages of moisture and salt, and the latter causes serious furnace refractory fluxing and plugging of the last tube bank. The problems of dirt from blast-furnace gas were presented but not discussed.

The necessity of reducing the number of coarse particles to a minimum in pulverized-coal furnaces as compared with absolute fineness was emphasized. One discusser pointed out the need for uniform fineness and said that a furnace cannot burn coal of two grades of fineness, owing to the fact that uneven grinding causes trouble. Another emphasized the necessity for limiting the coarseness so that all particles will go through a 100-mesh screen and stated that a high percentage of particles should go through a 200-mesh screen. Crushed coal and pulverized coal cannot be burned successfully in the same furnace, it was said.

2 *How can availability of boiler units be increased by shortening the outage time now required for internal tube cleaning?*

Boilers fired with natural gas or with oil present a simpler problem than coal-fired units requiring both external and internal cleaning. Filtration and recirculation of boiler water under pressure through anthracite was suggested. Silica represents a special problem. Control of pH is desirable. Sample tube turbining is used by one company to determine whether the boiler needs complete cleaning. Some high-pressure boilers have been operating without internal cleaning. Others are cleaned until a history is obtained. Water conditioning is a separate problem for each boiler plant, and until treatment is under control, turbining is necessary.

Corrosion must also be watched, particularly to prevent nodule oxidation. Cleaning with acid may or may not eliminate the nodule pitting as well as turbining.

One 700-psi installation has operated many years without cleaning. One operator reported cleaning every six months with acid but said that high-duty surfaces also require turbining. Scale on the hot or fire side of the tube contains 20 per cent silica, other scale throughout averages only one half of one per cent.

Dow Chemical was reported as having a separate acid-cleaning department for oil wells and boilers. The technique depends upon information obtained by taking a sample of scale and testing it for solubility. The object of using acid is to save time and labor cost. Acid cleaning is very effective in some cases.

An operator who has used acid for many years warns against its use in boilers where dead acid pockets might remain after draining. It was also pointed out that the internal surfaces should be thoroughly washed out and neutralized with good alkali.

A number of new boiler installations have been designed so that mechanical cleaning cannot be used. Acid cleaning is the only method available for cleaning such economizers and boilers.

One operator reported the burning of horizontal tubes because of the settling out of sludge in layers in some of the tubes. Hydrochloric acid has been used with special inhibitor.

3 *What are the possibilities of external tube corrosion or wasting occurring on furnace wall tubes of boiler units not equipped with slag-tap furnace construction? Has increase in total air at the furnace wall eliminated further attack where this type of corrosion has occurred?*

E. G. Bailey opened the discussion for the question with the following statement agreed to by three boiler manufacturers:

It is believed that external tube corrosion, or wasting, can occur on furnace wall tubes of boiler units having furnaces arranged for dry-ash

removal, if flame or fuel impingement is sufficiently severe. Quite a number of furnace installations have been inspected for this tube wastage condition, but to date no evidence of this condition has been found. On one installation, equipped with radiant superheater in the side wall, an attack of the chrome-vanadium tubes then used occurred about ten years ago. The cause was found to be severe flame impingement on the region attacked, and elimination of this flame impingement brought about a correction of the trouble. Increasing the total air at the furnace wall is probably equivalent to elimination of flame or fuel impingement. It is believed that any corrective measure that provides oxygen in the region where the attack is taking place should eliminate this type of attack.

External tube wastage has proved to be a serious problem in a number of slag-tap installations, and all agreed that it is a serious factor. While there is evidence that it has existed to some degree during the last five or six years, the extent of tube losses has culminated into a known problem quite recently.

There is unanimous opinion that the trouble is definitely related to zones of furnace walls covered with molten slag where the atmosphere is deficient in oxygen as indicated by the presence of an appreciable percentage of CO. The present cure has been to introduce additional air either through spaces between tubes of the wall or on the boundary lines of burners, so as to keep an appreciable oxygen content in gases adjacent to the walls. Both chrome paint and spray metalizing have been tried without definite conclusions. Iron sulphide was at first thought to be a prime factor, but evidence now indicates that the active wastage is usually in the presence of some alkali-sulphur compounds which analyze largely sodium and potassium sulphate after the boiler has cooled down.

It was strongly recommended that operators make full use of water-cooled sample pipes and gas-analysis apparatus to locate any objectionable pockets in the furnace and that they study burner distribution and the mixing of air and fuel.

4 *What amounts of ammonia can be tolerated in our steam and water circuits before troubles can be expected with dezincification of condenser and heater tubes and possible acceleration of internal boiler surfaces, the result of metallic copper deposits?*

One school of thought indicates that copper and boiler-tube corrosion might appear to be related because some copper has been found in corrosion barnacle pits. Another school believes that copper has not been responsible for the corrosion. Copper is soluble in ammonia and might be taken up from alloy parts and redeposited later in the boiler tubes. Copper has also been found in intercrystalline faces of boiler metal. There was a distinct difference of opinion—some of the discussers felt that if copper were not the cause, it was closely related to it. Another case of metal failure near copper gaskets was labeled by one discusser as being related to the copper but by another as being caustic embrittlement.

A case was reported in which 1 ppm of copper was found in the condensate from a heater with admiralty tubes; whereas, in another heater of exactly the same construction, the copper content in the condensate was many times as high, the only difference being a velocity of 4 fps in the case where the copper content was low and 7 fps in the case where it was high.

Condensate from air ejectors beyond the condensers is being discarded in some plants and the condensate from the intercondensers will probably be discarded in the future. Dry vacuum pumps were recommended by one engineer. Copper seems to come from no particular source. Ammonia is related to the source of water supply.

5 *What is safe practice to follow with respect to turbine inspection? Can present schedules of overhaul be lengthened?*

This subject was introduced by G. B. Warren with the following statement:

The general practice which has been suggested by the turbine manufacturers and agreed to by most of the insurance companies, and generally followed by the majority of turbine operators, is to inspect a new turbine unit in the period between six months to a year after it is initially placed in service, then to carry out subsequent inspections after approximately 10,000 hours of operation. This would, of course, require inspection under normal circumstances every two to five years, depending upon the operation of the machine.

On older turbines, that is, turbines more than 10 to 12 years old, it has been the general experience that inspections of this frequency are good insurance against unscheduled outages because potential difficulties can generally be anticipated and repair material accumulated in advance.

On more recent machines, on which bucket difficulties have been to a very great extent reduced, we find that the period from initial installation to the first inspection is the critical one because then difficulties due to foreign material or deposits, or those originating from design modifications, are apt to show up, and after that period it may be safe to extend the time between inspections.

The turbine manufacturer with which the speaker is associated, and he presumes the others, are making available to the operators an important tool in this connection. This is the curves of anticipated stage pressures against load which, if carefully checked by the operators with the actual stage pressures following initial operation and corrected thereto and from then on checked at frequent intervals against the actual stage pressures existing in the turbine under operating conditions, will permit the internal conditions of the machine to be watched very carefully. That is, deposits or damage due to the entrance of foreign material, or damage due to bucket difficulties, are immediately apparent; and it would seem reasonable to assume that as long as such data which have been taken indicate the machine to be in first-class condition, inspections could be intelligently and safely deferred.

The turbine manufacturers appeared to be in agreement in recommending an interior inspection of all new turbines within six months after installation, a year to be the maximum limit because in this period the major difficulties ascribed to foreign material, plant conditions, turbine design, defects, and other things will be evident. Manufacturers emphasized the desirability of catching the trouble before serious damage occurred and also in determining the trend of the internal conditions so that repair parts might be available for the next inspection. Very accurate records of stage pressures and exhaust temperatures in relation to load and steam flow were highly recommended, it being particularly desirable to obtain a set of readings representing the clean new conditions for reference use in later periods. It seemed to be generally agreed that the frequency of inspection required is related to the type of service. A machine which starts and stops frequently and is subject to high temperature stresses resulting from quick starting should be inspected much more frequently than one which is used as a base-load unit and is subject to few starts and stops.

It was suggested that both stage temperatures and pressures should be obtained. In reply it was pointed out that the measurements of stage temperatures and of steam quality on interstage points was a particularly difficult and unsatisfactory operation and that the steam-flow, load, stage-pressure, final-temperature conditions are sufficient to indicate the internal condition of the turbine. It was also pointed out that the inlet steam pressure and temperature and the final exhaust temperature and pressure, together with all extraction conditions, should also be recorded and, in so far as practical, duplicated on tests made for comparison purposes.

One manufacturer reported a case of a nine-year interval between inspections. In this case, as a result of the opening, the turbine was put out of service for a long period because of the technique of replacing some sealing strips which had become slightly eroded. This made the net effect of opening a very costly one. When the sealing strips were being replaced, the new ones were damaged and the machine had to be kept shut down until a second replacement set was made and in-

stalled properly. Opening turbines always introduces additional hazards in connection with lifting and replacing covers, lifting spindles, material being accidentally dropped into the turbine, overstraining of joint bolts, creation of new joint and packing leaks, and other troubles. The use of Magnaflux was recommended.

6 *What methods are available to prevent the loss in turbine capacity caused by the accumulation of soluble and insoluble deposits on turbine blades, buckets, and nozzle partitions?*

In opening the discussion of this subject G. B. Warren said:

The most feasible method to prevent loss of turbine capacity from internal deposits in the turbines is to furnish clean steam to the turbines from which deposits cannot be formed. The turbine manufacturers have, I believe, a keen realization of the difficulties that may be involved in this, but I am not certain that it is generally realized how detrimental these deposits may be to turbine capacity and efficiency, and to what extent they may be formed from steam having an extremely high degree of purity.

Steam deposits may be formed in various parts of the turbine depending upon the character of the material being deposited, whether it is soluble or insoluble, and the steam conditions and the operating conditions of the turbine and boiler. A very important variable appears to be the character of the ground water in the place where the plant is located, even though evaporated make-up is used. Soluble deposits generally form at earlier stages of the turbine, and insoluble deposits in the middle stages. Both kinds of deposits plug up the turbine passageways, increase the pressure drops across certain stages, and upset the energy distribution in the turbine, thus increasing the energy on certain stages and taking it off others, with resultant loss in efficiency, and seriously decreasing the hydrodynamic efficiency of the steam-path elements themselves. The action is probably very similar to that involved in the formation of ice on airplane propellers and wings, the disastrous results of which in airplanes are known to all newspaper readers.

The soluble deposits, although when present cause just as great difficulty in the turbine as insoluble deposits, are not so difficult to deal with because they can either be removed by washing, by shutting down the turbine for a period of a few hours or days and restarting, or, very frequently, by a period of light-load operation. All types of deposits tend to build up more rapidly and more detrimentally under steady high load conditions, and the soluble types are generally nearly absent in turbines subject to variable loads.

Although washing may remove deposits, it must be carried out extremely carefully to prevent damage to the turbine from differential temperature changes, takes a considerable period of time, thus requiring appreciable outage, and for obvious reasons should not be done more frequently than necessary. On the other hand, if not carried out frequently the reduction in capacity and efficiency may become appreciable before washing, and hence the general average of turbine efficiency and capacity is reduced. Although no generally acceptable method of washing out so-called insoluble deposits is known, at least two potential methods are under discussion and some test. The only certain method of removing insoluble deposits is to open the turbine and clean the steam passages with an air blast containing fly ash or other equivalent material.

There is some evidence, based on some German research work by a Dr. Spillner, that this problem is intensified by the trend toward higher pressures due to the increasing solubility of salts in the high-pressure steam in the boiler drum, and that it may not be due, as previously thought, to the mechanical carrying over of entrained moisture in the steam with its high concentration of boiler salts from the boiler drum. These tests would indicate to us that much might be accomplished by thoroughly washing the steam with the incoming feedwater between the boiler drum and the entrance to the superheater as has been tried with some success in a number of installations.

One important fact stands out, and that is that many plants have had serious deposit troubles which have subsequently been rectified, and that many plants are now operating, both low-pressure and relatively high-pressure plants, with no evidence of turbine deposits. This would therefore make it appear hopeful that this problem can be eliminated. The turbine manufacturers definitely feel that this is primarily a boiler and feedwater problem, but are, of course, ready to co-operate in every possible manner in its solution. It is hoped that the co-operative investigation now being undertaken by the Chemistry Subcommittee of the Prime Movers Committee of the Edison Electric Institute under the direction of Dr. Whirl of the Duquesne Light Company may yield important results.

The turbine manufacturers took the position that clean steam is the answer, their definition of clean being better than the purity now being supplied. They claim that the boiler manufacturers and operators do not realize how seriously the steam cleanliness affects the outage and capacity of the turbines because with the passage of millions of pounds of steam through the turbine, some accumulation will occur. Deposits vary widely. In some turbines, the first stages are clear, the intermediate stages accumulate an insoluble, and the last stages are clear. In others, soluble deposit accumulates in some stages and insoluble deposit is found in others. The turbine manufacturers pointed out that any deposit affects the aerodynamic efficiency.

Water-insoluble deposits have been cleaned by blasting with fly ash and by treating with caustic or hydrochloric acid. Soluble deposits have been removed under widely varying conditions—in some cases with water, at very slow speed, and in others with steam barely saturated, at full speed and load.

The new theory advanced by Spillner and others of the solubility of impurities in steam was discussed and the statement made that one investigator found ten times as much solubility at 2800 psi as at 1400 psi pressure. One operator by accident found that a change in steam pressure restored the turbine capacity. Chemists do not appear to know definitely in what form the silica is carried over, but it is probable that it is in the form of some soluble silicate.

The use of caustic emphasized the possible danger of caustic embrittlement and the possibility of having a large amount of deposit released at one time. In one case reported the rotor was lost following washing with caustic, and this suggests that a very dirty machine should not be washed under full load and speed if insoluble deposits exist. One case of serious turbine trouble was cured by the installation of separators in the evaporators. Other cases may require additional evaporator facilities.

Plants were reported as operating without treatment in the boilers and without load loss at 700 psi pressure. CO_2 in the steam was mentioned as a factor but there seemed to be no correlation between cases. One case with $^1/_2$ ppm CO_2 fouled, but another with 20 ppm did not. Consideration is being given to the introduction of CO_2. Mention was also made of plugging by magnesium hydroxide.

7 *What are the possibilities of removing present "bottlenecks" in existing power plants thereby increasing the maximum capacity?*

Attention was called to losses due to steam-line radiation, to the falling off of boiler feed-water heater performance by 20 or 30 F, to the co-ordination of operations so as to reduce peaks, and to a number of other opportunities which had been found in the steel industry.

Bottlenecks have been opened by attention to coal-pulverizer performance, stoker operation, induced-draft-fan vortexes, steam carry-over, furnace temperature, tube cleaning, circuit-breaker design, and turbogenerator operation on temperature rating instead of name-plate rating.

Another discusser illustrated the elimination of one bottleneck after another in a manner which gradually increased the capacity of the whole plant.

A case was mentioned in which, in the production of aeronautical gasoline, it was necessary to dispose of quantities of ordinary gasoline which had to be burned. Improvement of

diversity factors was emphasized as a means of eliminating bottlenecks in industrial plants, particularly where control of load is more practicable than it is in central stations.

8 *What is the experience in connection with turbine lubrication as to temperature, length of life, etc.?*

G. B. Warren opened the discussion of the subject with the following statement:

In many recent turbines trouble has been found upon first putting the unit in service on account of very severe rusting on the steel parts throughout the oiling system, namely, oil tank, oil lines, bearing pedestals, etc., although the bulk of the trouble has occurred in the oil tank. According to our lubrication specialists, the trouble was largely due to change in method and degree of refining of turbine oils to obtain what were considered important qualities, namely, absence of sludging and low steam-emulsion numbers. The older type of turbine oils, which had higher steam-emulsion numbers and which sludged more easily, contained natural rust inhibitors in a sufficient amount to prevent this rusting. We certainly do not want to go back to these old types of oil because they were extremely short-lived. We believe it is possible to retain the more highly refined oils and, through the use of corrosion-inhibiting additive agents, remove the corrosion hazard, while at the same time retaining the desirable characteristics of the newer oils.

Most of the troubles seem to occur in the early period of the turbine's operation when the operating group or the turbine erectors had frequently not been able to reduce to a minimum the entrance of water into the oiling system. Our evidence is that if the turbine oiling system can be protected for this interval by painting the pipes and tank walls, the oil may develop natural rust inhibitors in sufficient quantity so that thereafter the oil will wet the surfaces and thus prevent the development of the more severe types of corrosion we have met with. This matter is being given very careful attention, but is handicapped at the moment because of difficulty in obtaining some of the materials in the type of rust-preventing, oil-resistant paint which has had the greatest period of general service.

In the meantime, the specific oil company involved should be consulted by the new turbine owners and asked for a guarantee that the oil used will not cause this corrosion during the initial starting of the turbine; and if such guarantee cannot be given, it is my own judgment that the new turbine should be started on old oil or a large percentage of old oil.

Water appeared to be enemy No. 1. One discusser stated that sludge appeared to be a blessing in connection with very light oils because it permitted the turbine to be started without wiping the bearing. Heavy oil is needed for starting operations. Lighter oil results in less bearing power loss.

Considerable rusting has occurred in lubricating systems. Oil itself is not a rust preventative. Compounds have been used. The condition of the cooler is related to the quality of the oil and the temperature at which the bearings are operated. A drop in temperature from 170 F to 140 F increased the operating life between cleanings of the cooler to remove sludge from five weeks to fourteen months. Another operator reported that an increase in temperature from 135 F to 150 F resulted in a power-loss decrease from 255 to 187 kw. A decrease in oil life was expected but did not materialize.

Old oil was given credit by some for better lubrication than new; and in some cases new turbines are started with a large quantity of old oil. One case was reported of pilot-valve sticking within five hours after starting where all new oil was used.

The use of paint on the interior of cast-iron bearings and steel tanks was reported as unsatisfactory at first and as being satisfactory later when a paint was found which did not peel.

One operator used a suction fan between a bearing and a steam seal which was blowing badly. This was successful in preventing the steam from entering the oil system.

9 *What can be done to improve burners, particularly for mixed fuels?*

If sulphur is a factor, one quarter of one per cent may be enough to cause trouble; in few cases can sulphur be reduced to a figure below that amount.

Discussion switched to the effect of burner arrangement and flame erosion. One case was reported in which a tangential system, originally having a 4-ft circle, was changed so that rotation at the bottom was in a 1-ft circle, counterclockwise, and, at the top, in a 1-ft circle, clockwise. Erosion trouble on three walls was eliminated and the third greatly reduced by this change involving a better distribution of secondary air. Burning of mixed fuels is a very complicated problem. The distribution of air under stokers is very important and one plant found that it was very desirable to subdivide the wind box.

10 *What substitution can be made for essential materials required for construction and maintenance of power plants?*

This subject brought only one response, which related to a case of using asbestos roofing paper on low-pressure equipment joints as a substitute for rubber gaskets.

STANDARD BENDING ROLL MACHINE CONVERTED FOR USE IN RUBBER SALVAGE

(The Timken Roller Bearing Company, seeking a method of salvaging cable rubber, experimented with a standard Buffalo bending roll machine. This consists of three smooth wheels, two of which are in tandem beneath a third wheel which is centered above them. Varying pressures are exerted upon the material to be bent by raising or lowering the upper wheel. The one lower wheel was removed and replaced with a notched gripper wheel. A sharp center-flanged wheel replaced the upper wheel. No change was made in the third wheel. This conversion proved extremely effective in removing the outer layer of cable cloth insulation and the inner layer of fine rubber, which is so urgently needed at the present time. The gripper wheel feeds the cable between the flanged cutter wheel and the pressure wheel, slicing the cable open and peeling it simultaneously. Cable-rubber salvaging is accomplished at the rate of about 6 feet per minute. Cables ranging in size from $^5/_8$ to 2 in. are easily handled.)

QUALITY-CONTROL PROCEDURES *in* ORDNANCE INSPECTION

By G. D. EDWARDS

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THE current Army program involves acquisition of billions of dollars' worth of ordnance in a relatively short time. The Ordnance Department is under not only legal requirement but moral necessity to have definite evidence of the adequate quality of this material before accepting it for use by our fighting forces.

My assignment on your program is to describe for you a little of the part which so-called quality-control techniques have in the procedures involved in securing this evidence and a little of our approach to the problem of getting these techniques into proper use as rapidly as possible.

Up until now my business life has been with the Bell Telephone System where we have a continuing acceptance-inspection problem rather similar in character to that of the Ordnance Department. I have been fortunate enough to have been closely associated with this problem in the Bell System for 15-odd years, and to have been responsible for its general guidance at headquarters for the past 10 or 12 years.

The increasing difficulty of inspecting 100 per cent or even large percentages of the quantities of certain types of apparatus which the Bell System was using practically forced us into the beginnings of quality-control acceptance procedures as early as 1923. Not only were the economies of these procedures soon evident, but we found that under some circumstances we could secure noticeably better quality by their use than by 100 per cent inspection. The application of quality-control techniques in the telephone industry has thus grown to a point where we now tend to insist upon reasons for *not* using them, rather than on reasons *for* using them.

General Somers, who has been in general charge of inspection matters in the Ordnance Department, was quick to realize the great advantages which quality-control techniques would offer in important parts of the Department's tremendous procurement program, and he asked me if I would undertake to help him, particularly on those phases of his work which involved the application of quality-control procedures.

I had not been on the Ordnance job very long before I found that its similarity with the telephone one was pretty much limited to its character. I found, for example, that it was necessary to add a cool two ciphers after the dollar value of the total material with which I have been accustomed to deal in the Bell System, in order to get a corresponding figure for Ordnance matériel.

PERFECTION IN MASS PRODUCTION

We have a few items in the telephone industry, such as linemen's climbers, body belts, and safety straps, which are purchased by the thousands, where failure may be a real hazard to life or limb. For the Army, however, there are any number of types of matériel produced by the hundreds of thousands or even by the million in which certain kinds of defects mean almost sure death not merely to one but to a whole group of brave men who are perfectly willing to risk their lives in fair combat. The blood of these men will be on our hands if we leave any stone unturned to prevent their being done in as a result of defective ordnance.

I'm sure I don't need to tell you that if you are manning the lone aftergun in a bomber, with an enemy fighter on your tail, that fighter is likely to get the bomber and its whole crew including you, if a defective shell jams your gun before you succeed in putting him out of business. If you are inside a tank which is struck by a heavy shot, it won't do you much good to try to dodge the pieces of steel which spall off the inside surface of an excessively brittle armor plate and carom around inside the tank until they have killed or wounded every man they strike. If you are an officer or one of the crew manning a heavy gun and a shell explodes just before or immediately after leaving your gun because of a base cavity in the steel shell or in the explosive with which it is loaded, it is quite probable that you won't live to tell the tale. The gun itself may also be rendered useless at the same time to other men in the vicinity who are fighting for their lives.

These are representative of situations which we meet constantly in ordnance-inspection work and they call for a degree of perfection in mass production which has been uncommon in much industrial work in the past.

INSPECTION FATIGUE

Determination of the presence of many of the defects which will cause such dire results often requires test and inspection procedures which are themselves destructive. In these circumstances we are forced to take some chances if we are to give the field forces any ammunition, armor plate, or other matériel to fight with at all.

But even where the necessary inspections are not destructive, you all know our common enemy called "inspection fatigue."

If you have before you a hand truck containing say 15,000 cartridges, and you are given the job of inspecting and gaging them visually 100 per cent, I don't have to tell you that by the time you have looked at 9000 of them, they will all look alike to you, and you won't know whether the discoloration which evidences necessary shoulder anneal, for example, is there on the 9001st cartridge or not. This is no insult to your intelligence—it is just a plain illustration of experience.

So 100, or 200, or 500 per cent manual inspections are not the answer where large quantities of material are involved, even if we could put up with the resulting production delays. Mechanical gaging and photoelectric-cell gaging are being introduced wherever possible to eliminate inspection fatigue; but even the best of these substitutes have their margins of error.

QUALITY RISKS IN MASS PRODUCTION

In other words, we have to recognize that the element of risk just can't be eliminated from quality considerations in mass

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production, and the real problem is how to reduce the chances we must take to a minimum without unduly impeding output. Quality-control techniques are ***built*** around limiting such risks to a predetermined degree, and they are thus admirably adapted to the problem in hand.

I am not going to take up your time with any dry explanation of the theory or detailed procedures of quality control. Many of you are acquainted with both, and a wealth of literature is already available covering them. In fact I have had some feeling, on occasion, that the actual application of quality control may at times have been retarded by the apparent plethora of literature bearing on the abstract and theoretical sides of the problem.

What I want to tell you about is rather our point of view and approach to the problem of getting the principles of quality control into use in the far-flung Ordnance Inspection organization to the extent that it can be really helpful in *this War*.

PROPER USE OF QUALITY-CONTROL PROCEDURES

Of course, the great value of quality control lies in its ability to focus a spot light on the existence of unfavorable conditions before evidence that difficulties are developing would otherwise become available. It will do this, however, only if it is properly used, that is, if the right factors are selected for control watching, and if the mechanics of the control plan are so arranged and simplified that the necessary computations and plotting of inspection results will be carried out, and conclusions drawn from them, accurately and promptly.

If quality control is properly used in this way, an early start can be made on tracing the causes of difficulties, production of quantities of defective material can be avoided, testing and testing-equipment, time, and material can be conserved, actual stoppages of production can be prevented in some cases, and inspection can be converted from a hindrance to a boost for output.

So the first essential in ordnance-inspection work is that our own quality-control procedures be simple; and the second is that when such a procedure is introduced it be operated expeditiously though with meticulous conformity to the detailed provisions of its plan.

ENCOURAGING MANUFACTURERS TO CONTROL QUALITY

While all of the results I have cited from the proper operation of a well-designed quality-control plan will obviously redound to the immediate benefit of the manufacturer, these results also make it evident that it is distinctly to the advantage of the Ordnance Department for its manufacturers to have the quality of their products in control, particularly in these days when output of satisfactory matériel is all-important.

Ordnance inspections for acceptance may hence well be so planned that they will encourage manufacturers to get their quality into a condition of statistical control. The evidence, which control at a satisfactory level provides that quality is acceptable, is a perfectly sound basis for reductions in the volume of acceptance inspection. Such reductions cut down the amount of finished product awaiting acceptance, which the manufacturer must keep around in his own way; they eliminate the provision he must make for housing such material; they correspondingly reduce his inventory; and they enable him to get his money back more quickly. This sort of encouragement to control can thus be made quite persuasive to the manufacturer. At the same time the Department must be wholly impartial in its inspection and acceptance of good Ordnance matériel, regardless of whether or not the producer of such matériel uses any statistical approach whatever to his quality problem.

However, we like to look forward hopefully to a time when, for some types of matériel at least, manufacturers who have demonstrated their own dependability and sufficient quality control might possibly, with adequate Ordnance oversight of their inspections, provide ***themselves*** at least some of the quality evidence necessary to Ordnance acceptance of their product.

Some types of matériel, such as armor plate, for example, can only be inspected and tested on a sampling basis, and the sample is destroyed in test. Any sample at all thus consumes precious plate which we would much prefer to have on tanks or planes. Quality-control procedures make use of the continuing results from a succession of samples which individually can be extremely small in percentage as long as control is maintained. The risk of accepting poor plate under these conditions can be held to substantially lower levels than would be possible with much larger samples and no quality-control procedure.

ELIGIBILITY FOR REDUCED ACCEPTANCE INSPECTION

In approaching such a quality-control problem, we are requiring samples from every production lot of output for a time. As soon as the inspection and test results from a series of consecutive lots are uniformly within control limits, the manufacturer becomes eligible for a reduction in inspection. Continuance of such evidence of control would reduce the proportion of lots from which samples of the same size would be required, in successive steps, to a half, a quarter, and perhaps even lower. If the manufacturer loses control, he loses eligibility for reduced inspection, and it can only be regained by his regaining control of quality.

Now for the perennial question about the bad lots of product that might be accepted under this plan, before lack of control becomes evident. The answer, of course, is that without a control procedure, and even with perhaps larger samples from every lot, we would be just as likely, and perhaps more likely, to accept bad lots of product. So even in those rare instances where there is no urge to reduce inspection, the application of control criteria to the existing inspection procedure will reduce the risk of accepting bad product. At the same time we acquire a means for determining what that risk is, so that we can decide whether or not we are inspecting as thoroughly as we should.

This whole question of defective material is something like a boil on the back of a man's neck. The amount of attention the man devotes to it is out of all proportion to the comparative weights of the boil and of the rest of his body. The worse the boil gets, the greater this disproportion. But once the poison gets out of the boil and it is reduced to the small-pimple class, it demands less and less of the man's attention.

If the defective material produced by a process approaches boil proportions, it won't do any good merely to pick at it with your inspection fingernails. You can't "inspect" into a product quality that was not put there by the manufacturing process. The manufacturer has just got to find the source of the poison and correct the process. Once he gets the boil reduced to pimple proportions, he can keep his eye out by inspection means to make sure it doesn't get bigger again.

We have no intention of allowing the ordnance inspector to become a sieve for weeding out defectives from the product of a low-quality manufacturer. That is the manufacturer's job. But we will help him to get the quality of his product under control at a satisfactory level by advising with him and by making constantly available to him all information as to levels and trends in his quality which may be evidenced by ordnance inspection results on his product.

QUALITY-CONTROL PROCEDURES MUST BE TAILOR-MADE

If you happened to make use of Prof. W. F. Osgood's text in your study of the calculus, you will perhaps remember that after describing various methods of accomplishing integration

(such as integration by substitution, integration by parts, etc.), he comes to a final method which is nearly all-inclusive and far more powerful than any of the others, and he calls it "integration by ingenious devices."

I think this approach is an ideal one in connection with the inspection problem. The best acceptance inspection procedure to use in any particular set of circumstances will be largely tailor-made to fit the type of product, and it will take advantage of every "ingenious device" possible for drawing conclusions from the local conditions under which the article is produced and inspected by the manufacturer.

DECENTRALIZING THE INTRODUCTION OF CONTROL PROCEDURES

On this thesis, the adaptation of Ordnance acceptance inspections to encourage manufacturers to control the quality of their products must be left as far as possible to the Army inspection personnel out in the Ordnance districts of which there are thirteen blanketing the country. Any attempt to centralize such work in Washington or elsewhere would not only "bottleneck" it but would seriously interfere with the application of what I have called "ingenious devices" to local conditions.

These adaptations must follow uniform patterns and principles, however, in order to avoid such things as rejection by one district of matériel which would be accepted by another. The Office of the Chief of Ordnance must hence provide these uniform patterns and principles in the form of approved references to available general publications, and by issue and distribution to the districts of general standards where necessary.

AMERICAN EMERGENCY STANDARDS FOR QUALITY CONTROL

Perhaps the most useful illustration of such a general reference is the recent pair of "Emergency Standards for Quality Control," released by the American Standards Association and numbered Z 1.1 and Z 1.2. These standards were prepared by a committee set up for the purpose by the Association at the request of the War Department, and they put the meat of practical quality-control procedures into small compass and words of one syllable for the first time. A third such standard will be forthcoming shortly, which will be particularly helpful to manufacturers who wish to get the quality of their products under control and keep it there.

INSPIRATIONAL CONFERENCES FOR ORDNANCE INSPECTION PERSONNEL

The personnel out in the Ordnance districts who will tailor-make specific quality-control adaptations of inspection procedures from the generalized information released by the Office of the Chief of Ordnance require a certain amount of educational and inspirational guidance and instruction in some cases of course. To meet this need, we have undertaken a program of training conferences for inspection representatives from the Ordnance divisions, districts, and arsenals.

These training conferences are not occupied with deep abstractions or excursions into the theoretical phases of mathematical statistics. The quality-control principles which can be brought to bear effectively on new ordnance production in time to be of real aid in this War are again simple.

I like General Somers' homely illustration of the watch. All of us use them, and we know whether they keep time with sufficient accuracy for our individual purposes; yet few of us would even attempt to repair one, let alone design and make one.

So it is with quality control. The principles necessary for its immediate uses can be presented to the average layman of reasonable education in such language that he can understand and use them without his necessarily taking the time to delve into all of their theoretical bases and refinements. The average inspection supervisor can certainly acquire in short order the habit of plotting his experience with a particular product against time or against output; of putting simply computed limit lines on his chart; and of noting significant quality trends or departures from the proper levels. He can certainly be taught that some all too commonly used sampling inspection procedures accept product which does not differ significantly in quality from that which they reject; that there are procedures, often requiring less inspection, the use of which will largely reduce the amount of good material rejected and at the same time will improve the over-all quality of the material which he accepts; and what is the general nature of these latter procedures.

Some commonly used sampling inspection procedures appear to have been invented by men who have never played poker. If you draw a five-card hand from an honestly shuffled, honest deck, none, some, or all of the cards in your hand may be face cards of course. If your hand contains no face cards, you certainly cannot conclude that the deck contains none. Yet I have seen cases, and Ordnance inspectors are far from the worst offenders, where ten per cent samples were being drawn from containers of fifty-piece parts (that's about the same as a five-card hand from a fifty-two card deck), and a container was being rejected as soon as a defect was found in its sample. The accepted containers were probably just about like the rejected ones of course. That sort of thing just isn't necessary.

In the training conferences which we have undertaken, we are covering little more than the simple and immediately necessary principles directly applicable to the sort of problems which I have touched upon. But we expect the men who are attending these conferences will provide a leaven of quality-control men in their several locations throughout the country for critically reviewing the results of the inspection of matériel, for constructively criticizing and improving inspection practices, and for establishing quality-control acceptance inspection procedures on selected types of matériel in various munitions industries. From these selected types of matériel, quality control can be spread type by type until its advantages are extended at least to the greater percentage of those Ordnance inspections where it will be immediately helpful.

Some of the quality-control inspection arrangements and procedures which will originate in these outlying locations will of course require approval from the Office of the Chief of Ordnance, since their acceptance criteria will occasionally involve waiving of some of the acceptance-inspection requirements of Army specifications.

In general, however, the program involves decentralization of the planning and installation of the procedures, leaving to Ordnance headquarters only educational, inspirational, and general standardization work, together with such approvals of specific plans as necessary.

Vocational Education and the War

(Continued from page 666)

in that capacity determine the policies of democracy. Democracy is not safe until the people have been prepared to participate intelligently and rationally in the conduct of their own affairs. The production of a constructive attitude toward government is not possible merely by waiting for it to develop. Let us remember this—each one of us is a citizen, whether he be a college graduate or possess merely a sixth-grade training. No one asks how much education one has or what his intelligence quotient is when he casts his vote, runs for office, serves on a jury, or buys goods. The security of this country is vested in a trained citizenship. The first line of defense for the country is a citizenship prepared to do the work of the world; that knows and is prepared to defend the things for which this country stands.

DEMOCRACY *and* COLLECTIVISM[1]

By RALPH E. FREEMAN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAPITALISM, the system of production based on private ownership and initiative and motivated by the desire for profit, is on the way out. Overwhelming evidence of this is to be found in the chronic debility of a great section of industry and agriculture and in the mass unemployment and the stagnation in investment and enterprise that recur with increasing intensity in each succeeding business depression, and especially in the depression of the thirties from which only war could bring recovery. This is the contention of Carl Dreher in "The Coming Showdown."[2] The book contains a powerful indictment of capitalism beginning with the Industrial Revolution and ending with the bungling efforts of this country to mobilize its economic resources for the struggle against Hitler. The basic cause of the failure of the system is to be found in the rise of powerful monopolies whose policies result in restriction of output. Prices are kept so high and wages so low that the consuming market will not absorb the potential output of the system. "The workings of this system of private enterprise are such that, under normal conditions, just as a third of the population is chronically underfed, the whole industrial machine is likewise underfed. This state of affairs does not worry the big producers too much, because as long as not too much is produced they can produce most of it and exact high prices. They are in charge of the underfeeding; they are not underfed themselves." The author claims that there is a fundamental conflict between capitalistic business with its restrictive tendencies and modern technology with its impulsion toward greater and greater production. In this struggle technology will destroy capitalism.

To anyone who has some acquaintance with modern economics, Mr. Dreher's reasons for the failure of our economic system to provide full employment will be unsatisfactory. On the other hand, there will be general agreement with his main contention that there is something seriously wrong with capitalism. Most readers, indeed, will not require the detailed evidence of failure which is assembled in the first 300 pages of the book. They will be highly interested, however, in the proposed successor to capitalism. This successor, states the author, is collectivism—"a type of political and economic order which makes over-all co-ordination of industry and national economic planning possible."

Capitalism prevailed over feudalism because it produced better; and collectivism will prevail over capitalism for the same reason. The superior efficiency of collectivism was demonstrated in World War I and is being demonstrated again in this war. The long and costly delays of the first World War were "due in part to the eagerness of business to get all it could out of the war, in part to blind faith in the capacity of free enterprise to meet any situation by the operation of its so-called automatic controls, and in part to old statutory embodiments of that faith." As to this war the author concludes that the "formidable industrial potential of the United States is restricted and thwarted at every turn by the practices of business as usual. The O.P.M. did not relieve this occlusion, rather the contrary. In the matter of forecasting shortages of materials and machinery the President would have done better to rely on the editors of the *New Republic*." As Mr. Baruch said in 1931, "Modern war is impossible without a sanction, control, and leadership in industry sufficient to organize and deal with it as practically a single unitary system."

The merit of dealing with our peacetime economy as a single unitary system is demonstrated also by the experience of Germany. In spite of important defects Fascism has its points. "The Nazis have got rid of the orthodox capitalist inhibitions which stand in the way of full employment of a nation's man power and resources, for whatever purpose. They have put the horse before the cart: they made up their minds what they wanted to do, they planned it, and they made finance serve the plan, not the reverse. They figured that if they raised public expenditures to thirty billion marks a year, for a start, the nation would be put to work again, and they could pay the bills. It was not nearly as big a gamble as classical economists imagined. The Nazi economists knew it could be done, and they did it."

The author, however, does not propose Fascism for America. Enslavement of wage earners, suppression of free inquiry, race persecution, aggression, and the other unsatisfactory social features of the Nazi system render it extremely repugnant to freedom-loving people. But since collectivism is inevitable, Fascism is what we will get if we do not adopt a collectivism of our own choosing. Democracy must adapt itself to collectivism. "It must be able to do all the things that totalitarians can do, and do them better. It must plan better than they. It must achieve full employment as they have done and for better ends." This is the coming showdown. Which collectivism? The despotic variety that enslaves the workers or the democratic variety that achieves planning under the control of the mass of the people? "Fascism has this strength: it is consonant with the machine process. We cannot fight it with something that bucks the machine process. Democratic collectivism has the same advantage. Otherwise the differences are polar. Democratic collectivism undertakes to subordinate the machine to the human being for the creation of a civilized existence for all men, while under fascism ordinary men are chained to the machine for the benefit of the capitalist, the militarist, and the party gangster, constituting a tripartite elite which, no doubt with some modifications in organizational structure and slogans, could also co-ordinate men and machines in the United States."

Most students of the history of society would agree that a definite movement toward collectivism has been observable for some time past and many would be willing to predict that this movement is likely to be accelerated as a result of the war. Mr. Raoul de Roussy de Sales, in a stimulating book[3] published this year, holds that the mightiest forces clashing within the United States and every other country in the world are nationalism, collectivism, and pacifism. This book might well be read along with "The Coming Showdown." It places the trend toward collectivism in its setting among great world forces. "If Nationalism is the greatest single force in the

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "The Coming Showdown," by Carl Dreher, Little, Brown, and Company, Boston, Mass., 1942.

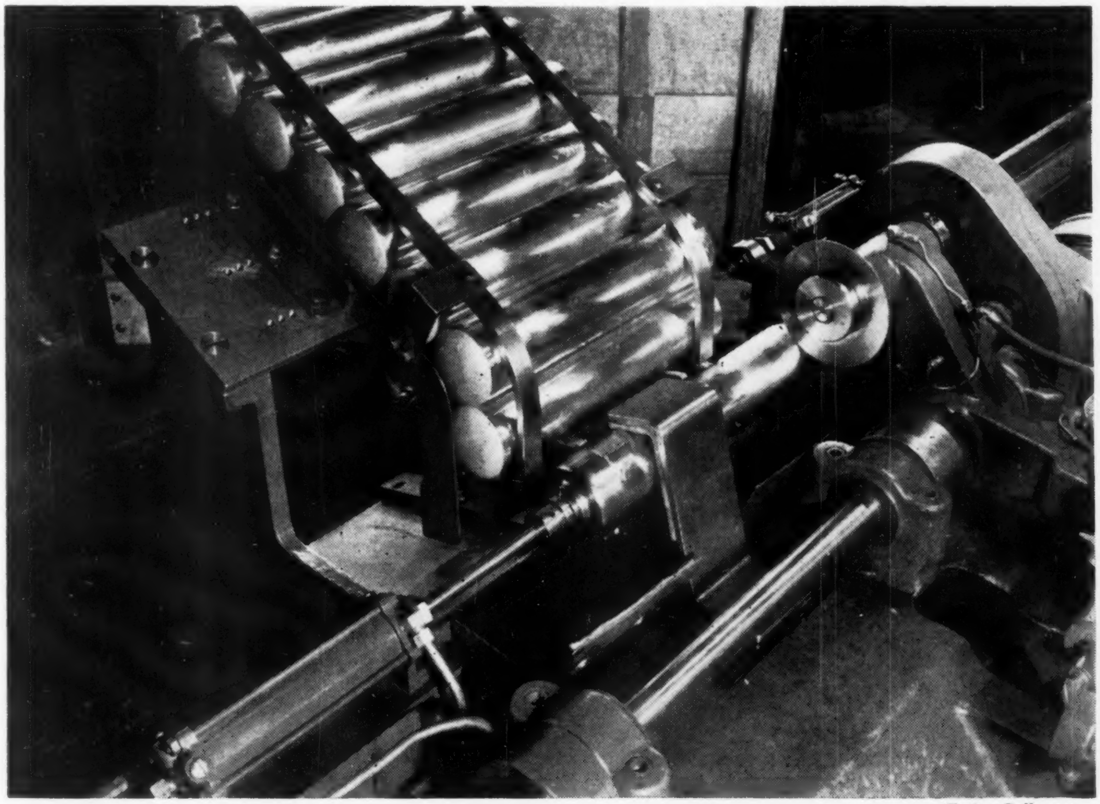
[3] "The Making of Tomorrow," by Raoul de Roussy de Sales, Reynal & Hitchcock, Inc., New York, N. Y., 1942.

world of today and accepted as the one categorical imperative that cannot be disputed, the trend toward collectivism can be considered as no less irresistible and no less universal."

The vital question of the future, according to Mr. de Sales, is not "whether democracy can be made to work according to capitalist formulas or socialist doctrines. The imperative of collectivism disregards such subtleties. The dilemma is whether a collectivist society—that is, one founded on our real possibilities of production—can be established without destroying the essential principles upon which democracy rests." Mr. Dreher is confident that this achievement can be accomplished. He outlines in chapters 22 and 23 some of the main features of a possible collectivist system which retains many democratic features. Though the plans for this regime are to be drawn up by engineers and technicians, the representatives of the people are to be given power to accept or reject the plans. Operation of industry would be decentralized as far as possible in local governments, co-operatives, and public groups of various kinds. Agriculture would be reserved as long as possible as a frontier for modified private enterprise. Newspapers might be run by editorial boards elected by labor unions, universities, consumer co-operatives, and similar organizations. The right to strike would be preserved. Even a certain amount of valuable competition would be fostered. Space will not permit of giving Mr. Dreher's suggestions in full. He does not claim originality for them, nor completeness. He admits that they raise as many questions as they answer. But the principal shortcoming of his sketch of a possible new order is that it does not convince the reader that collectivism in its revolutionary form is compatible with democracy.

Mr. de Sales writes that "democracy can survive only by avoiding at all costs any drastic step that would mark a definite break with the customs, habits of thought, and the will for permanency that is the chief characteristic of a living organism, whether it be an animal, a school of art, or a form of civilization." Mr. Dreher is an engineer—he would reject this view. He would probably classify it as "an assumption which paralyzes the will. And the assumption may turn out to be as wrong as the remark which one of a group of bankers, lawyers, and economists made to Thurman Arnold just before the bank holiday of 1933: 'My mind fails to function when I think of the extent of the catastrophe that will follow when the Chase National Bank closes its doors.' The Chase National closed its doors, and very little happened. Suppose the banks had not reopened. Would the United States have blown up like a toy balloon when a lighted cigarette is touched to it? I doubt it."

There is undoubtedly something in Mr. Dreher's idea that "the surest way to achieve disaster is to attempt to stave it off by fighting to preserve the past." On the other hand, it might be unwise to scrap an economy, however imperfect it may be, which has enabled the nation to achieve the highest level of living in the world. The proposed substitute has admittedly proved more efficient as a means of organizing a war economy; but the economic problems of war are not the same as those of peace. Under these conditions it might be wise for us to proceed cautiously, to modify our economic system by the gradual extension of governmental control rather than to replace it all at once by an entirely different system. If, on the other hand, Mr. Dreher is right that we must choose between the two revolutionary forms of collectivism, there is no question as to our choice. But one may reasonably doubt that these are the only courses open to us; one may even have doubts as to whether a really democratic collectivism is attainable.



Ewing Galloway

SHELL MANUFACTURING
(The cutting to size of 75-mm shells.)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Quality Control

COMMENT BY H. F. DODGE[1]

This paper[2] provides an excellent illustration of a point which cannot be overstressed; namely, that in applying quality-control techniques, based on statistical methods, only a small amount of the work is statistical, the great bulk, well over 90 per cent, being engineering. Success depends primarily upon engineering judgment and an intimate knowledge of all of the factors in the manufacturing process which have a bearing on variations in the quality characteristic under consideration. Such variations arise from a myriad of causes, contributed by materials, men, and machines.

In planning a control procedure for any quality characteristic, therefore, one must first make a close study of the entire production process, gathering sufficient data of a preliminary sort to provide a picture of the behavior of the process, with particular attention to the variations in quality from day to day, as well as from operator to operator, and machine to machine. Simple statistical techniques, such as those provided by the quality-control chart, may be used for appraising the existing situation. From analysis of such data, one then is usually in a position to set up some definite procedure to be followed in the routine testing and inspection of the product.

The place to get control is right inside the manufacturing plant, at the bench, at the machine, where the causes of variation are operating. With this in mind, inspection should not be considered merely as a means for accepting and rejecting individual lots of product one by one, but also as a means for making adjustments in the process itself. True, the inspection must serve the immediate purpose of disposing of the product at hand, but it can also serve as a basis for action on the process with a view to regulating the quality of future product.

Any quality-control scheme to be effective should have criteria for definite action on the process, such action to impose some kind of penalty on the organization responsible for quality. The procedure described in this paper is a model of simplicity. The inspector inspects every two-hundredth weld and records the shearing value. A low value requires stopping the welding machine and readjusting it. A very low value requires not only stopping the machine and adjusting it, but also stripping and rewelding the contacts on the 200 preceding parts. These penalties are the crux of the matter for, if they are invoked too often, production will be unduly interrupted and the rebuilding of parts will become burdensome—a condition that the producing organization cannot tolerate. The entire plan thus exerts economic pressure on the production group, which serves to provide a definite quality incentive.

Wherever such procedures are introduced, almost invariably there results one or more advantages such as reduction in rejections, reduction in the cost of inspection, and reduction in the width of engineering tolerances which can be met.

These are matters of special importance in times of emergency for they may aid in speeding up production, in reducing costs, and in making more efficient use of materials.

[1] Quality Results Engineer, Bell Telephone Laboratories, New York, N. Y.

[2] "Quality Control With Sampling Inspection," by C. S. Barrett, MECHANICAL ENGINEERING, May, 1942, pp. 361–364.

Urea Treatment of Lumber

COMMENT BY M. H. BIGELOW[3]

UREA apparently is the "wonder" chemical of industry. At the outset it is the first organic compound to have been produced synthetically. Then, instead of lying tucked away in the rare-chemicals cabinet, it has become the backbone of one of the largest chemical industries, namely, that of synthetic resins. While all this has been going on, it holds an excellent position in the field of fertilizers and has even branched into the fields of medicine. It is used as a treatment for flesh wounds, and lately its use for dental hygiene has been indicated.

The author of the present paper[4] has conclusively shown this overworked chemical to be the lifesaver of the lumber industry. He leaves no stones unturned to prove his point.

While laboratory and commercial tests indicate the validity of the author's statements, his theory ties in so closely with the simple conception of what may take place when lumber dries that little doubt exists in the writer's mind that the urea treatment of lumber will become a standard practice. It is fortunate indeed that the cost of urea is low enough to make it commercially usable.

While urea promotes the aging of wood with a minimum of checking, the writer wonders about the stability of such wood when used under strenuous climatic conditions. Obviously the urea will be leached out of the wood. Naturally some swelling will take place. When dried will there be checking? If the urea has not interfered with the shrinkage phenomenon so that the ultimate shrinkage can be reached, obviously, checking will be a minimum. It will be worth while to watch the future development of this interesting chemical.

[3] Director of Technical Service, Plaskon Company, Inc., Toledo, Ohio.

[4] "Urea Treatment of Lumber," by J. F. T. Berliner, MECHANICAL ENGINEERING, March, 1942, pp. 181–186.

COMMENT BY W. KARL LOUGHBOROUGH[5]

Chemicals have been used as an aid in seasoning wood for generations, but no one knew how or under what conditions their use was beneficial. Hence no progress was made.

As Dr. Berliner points out, modern chemical seasoning has already accomplished wonders. Based on the history of lumber seasoning, we seemed to have accomplished a miracle when, in 1935, a boxed-heart 12-in. × 12-in. Douglas-fir timber was first seasoned at the Forest Products Laboratory to a moisture content of 10 per cent without the development of any checks. Boxed-heart tim-

[5] Senior Engineer, Forest Products Laboratory, U. S. Department of Agriculture, Madison, Wis.

bers are mentioned because wood normally shrinks about twice as much on a percentage basis in the direction of the circumference of the tree as it does in the direction of its radius. The normal shrinkage of wood in drying must, therefore, inevitably produce a V-shaped check in logs or large boxed-heart timbers. However, by chemical-seasoning methods we were able to reduce the ratio of tangential-to-radial shrinkage to 1:1, and in this way produce a dry unchecked timber that was at the time unique in human experience.

As the originator of modern chemical seasoning and the first to use urea as a chemical-seasoning agent, the acceptance of the process by the industry is naturally gratifying to the writer. We would like to think that we had discovered a simple panacea for all lumber-seasoning ills. We would like to shout its virtues from the housetops, but because of our responsibility to the public and the danger of overstatement, we do not allow ourselves the luxury of generalizations. The Forest Products Laboratory has actively studied chemical-seasoning methods for about 8 years, and during that time we have learned to approach each new chemical job from an experimental point of view.

The writer is in substantial agreement with all the detailed information which is contained in this paper. The only criticism is that, in his judgment, its tone is overoptimistic, and it does not sufficiently stress the fact that the processes developed for chemically seasoning each respective item must be carefully worked out, not only from the standpoint of cost of producing check-free material, but also from the standpoint of consumer satisfaction. The writer would like to encourage the individual manufacturer to believe that chemical seasoning has great promise, particularly in the seasoning of slow-drying, refractory items. At the same time it should be pointed out that the process of chemically seasoning any untried species or item of wood must be developed by painstaking research before its commercial merit may be judged. It is not safe to assume, for example, that because urea has been used successfully in seasoning Douglas-fir clear timbers that the same methods could be profitably employed in seasoning No. 2 common Douglas-fir of any size.

At present there is a demand for dry 3- and 4-in. oak. While we know that suitable chemical-seasoning treatment followed by drying by exacting kiln schedules will minimize seasoning degrade, we do not know whether the practice would be economically feasible. This is particularly true when it is realized that the inherent seasoning characteristics of oak differ so widely. Large items of some species may require a chemical treatment before they can be seasoned. In other words without chemical seasoning, it may be more profitable to leave such trees on the stump in the forest. On the other hand because they can be seasoned with comparative ease by ordinary methods of kiln drying and air drying, it may develop that certain species of oak may be more profitably seasoned without preliminary chemical treatment. Again it does not follow that because the larger sizes can best be kiln-dried after chemical treatment that 2-in. squares should be seasoned by the same method. In fact our data indicate that the yield of perfect stock in squares up to three inches is greater when they are air-dried after a suitable chemical treatment.

After chemical seasoning we have a product which is not strictly wood. Its properties have been modified by the absorbed chemicals. The new properties may or may not be an improvement over the natural properties of the wood and more often than not the appraisal of the new properties will depend upon how the wood is to be used. Urea, for example, darkens southern swamp oak enough to render it unfit for average furniture use. Appalachian oak is not discolored to the same extent but the longer soaking periods required to give 3- and 4-in. oak immunity against seasoning degrade produce a discoloration that would be objectionable for certain uses. Dr. Berliner points out that the darkening is intensified by high treating and drying-temperatures. Without using elevated temperatures, however, the drying process is prolonged and its resultant cost is proportionately increased. Where color in oak is important perhaps we may learn that heavy items should not be treated with urea because they cannot subsequently be subjected to economic kiln temperatures.

Under these conditions it may develop that the oak should be treated with chemicals which do not discolor it. Glycol and sodium chloride are examples of this latter class of chemicals. For certain species and lumber uses, urea makes an ideal chemical seasoning agent.

The author's examples of his success are decidedly encouraging, but undoubtedly he will agree that at this stage of the study we should avoid the conclusion that we have solved all the problems. Modern chemical seasoning is a new and effective tool in the art of lumber drying. It may be said, however, that it is a sharp two-edged sword which must be used with understanding and skill if it is to produce the best results.

Author's Closure

When green lumber is properly treated with urea and dried, the presence of the urea in the outer shell during the drying process reduces the tendency of the wood to develop tension stresses and thus minimizes or eliminates the formation of checks. If this dried urea-treated wood is exposed to the elements, the urea, being water-soluble, would tend to leach out and subsequent alternate drying and wetting of the wood would develop checks as in untreated wood. Also, urea is usually applied to rough-sawed wood and after drying, the surface of the wood with most if not all of the urea may be removed by planing, sanding, or turning. The resulting wood is then the same as if it had not been treated and, subjected to the same external conditions, would behave similarly.

The author is, of course, in complete agreement with the comments made by Mr. Loughborough and considers of particular importance the point made that results obtained with one type of lumber cannot always be applied to different items even if of the same wood species. As more mill experience is accumulated, it may eventually be possible to predict the applicability of chemical seasoning for most items. However, at present, while general recommendations can in many cases be made on which to base mill-scale tests, definite procedures can be given only for a relatively small number of items. Mill trials are needed to establish the effectiveness of the treatment, the most practical means of applying the chemical, and the conditions best suited for handling and drying the treated lumber.

Generally, chemical seasoning should be considered for any item where the seasoning degrade represents a monetary loss greater than the estimated cost of the chemical-seasoning process, or where sufficient savings could be made by kiln-drying green wood, or by decreasing drying time in the kiln. Investigations may show that the improvements or savings derived from the urea treatment are not enough to make the treatment attractive. In at least one instance, investigations incident to considering the adaptability of urea seasoning led to such improvements in handling and drying technic that these in themselves produced the desired benefits and use of urea was not necessary.

While the results obtained in the laboratory and from small-scale kiln operations give us some basis for comparing certain limiting factors, unfortunately, the information thus obtained can seldom be directly applied to large-scale operations. Laboratory studies can only point the way. It is virtually impossible to re-

produce on a small scale the conditions to which lumber is subject in commercial handling. Mill-scale results have in some instances proved better and in others worse, than would have been predicted from information obtained from small-scale tests.

There are still numerous unsolved problems associated with chemical seasoning. For instance, the exact role of urea in the mechanism of the drying process presents some as yet not satisfactorily explained anomalies. There is still much to be learned regarding the optimum kiln conditions for drying urea-treated lumber. In some species, discoloration has been encountered in some pieces and not in others of the same wood from the same locality under what were ostensibly the same conditions of treatment and handling. Hitherto, relatively unexplored fields in wood technology have been opened up by the discovery by Mr. Loughborough that wood and wood products impregnated with sufficient urea are thermoplastic. This has created considerable interest and shows promise of developing into commercial importance.

J. F. T. BERLINER.[6]

Conserve Man Power

TO THE EDITOR:

The photograph on the cover of the June issue recalls a similar photograph which aroused the ire of one of the members, apparently because of the "sloppiness" of the machine operator in permitting the machine cuttings to accumulate around the machine. Frankly speaking, I would far prefer a man to allow the cuttings to gather on the machine, as shown on the June cover, than to see a picture which would show nothing.

There are too many "desk" engineers, who are in positions because of the present emergency, and who would like to impress on mechanics—men who know the intricacies of their jobs better than the engineer does—that "Cleanliness is next to. . ." and other ballyhoo.

Too many accidents have been caused by machinists who attempt to wipe tool cuttings away from the machine tool. Fingers have been split open and lopped off, hands sliced, and arms broken. Every one has been recorded, to use the machinist's own term, as "trying to clean the cuttings away." Some indemnity company's factory safety inspector would class that type of accident as "carelessness," which is incorrect because the machinists in question obeyed a nonsensical law about keeping their machines clean at all times.

In one plant I saw an electrician break his arm by permitting his overall jacket to be torn and wound around the drill. Why was his hand so near the drill? The hand that was caught was trying to break the steel cutting winding up the drill flute. He was methodical. As the cuttings arose in the flutes, he broke them off, "so it wouldn't make a mess of the floor."

Now let us look at the photograph, examine it carefully. Note the type of machine "cuttings," then look at the job in the "chuck." Probably a brass or alloy bushing or collar is being machined. Next, note how the machinist leans toward his job.

Does that signify good practice? Far from it!

In the first place, where are his goggles? What chance does this machine operator have in the event of a cutting flying off and possibly striking him in the eyes?

In the present emergency a man without eyesight is no good on a lathe, planer, milling machine, or a boring mill, or any other type of machine.

There are numerous types of face guards on the market, but why aren't they bought for protection?

It is up to every engineer to see that the men in his department are equipped with accident-prevention materials—face guards, goggles, safety shoes, steel helmets, where such devices should be used.

Train the men to use them. Make the men use them! Then stand back and watch the accident frequency diminish.

Remember: Conserve man power and preserve equipment.

JOHN M. GORRIE.[7]

Oil-Field-Tank Batteries

COMMENT BY M. H. KOTZEBUE[8]

The writer's observation, as a result of numerous tests made in conjunction with proposed gasoline-plant installations,[9] has been that the fractions saved because of increased pressure on oil-field-tank batteries have consisted largely of butanes and pentanes. Inasmuch as isobutane is needed for the manufacture of aviation gasoline, and as normal butane and isopentane have an octane rating of about 90, the actual value of the saving is no doubt much greater than the increased value of the crude, especially at the present time.

Marine Boilers

COMMENT BY MILTON KARR[10]

It is requested that the author of this paper[11] supply information on the following matters:

1 In connection with the operation of a divided-furnace separately fired superheater boiler, may the boiler be operated on the saturated side alone with the main steam stop valve to the superheater closed without damage to the superheater?

2 What is the magnitude of the natural draft obtained for the foregoing type of boiler installed in a naval vessel? Is it of sufficient magnitude to operate the boiler without forced draft at extremely low firing rates?

AUTHOR'S CLOSURE

In answer to Mr. Karr's questions the following information is given:

1 Boilers of the divided-furnace separately fired superheater type may be operated with the burners on the saturated side alone, with the main steam stop valve from the superheater closed, without damage to the superheater, as has been proved by repeated operation under such conditions both at a test plant and on ships in service. Under these conditions saturated steam for auxiliary purposes is taken directly from the boiler drum in quantities as high as 30,000 lb of steam per hr. When operating with the burners under the saturated side only in use, the superheater drains should always be open to their traps to dispose of the condensation which otherwise would collect in the superheater.

2 The magnitude of the natural draft which may be obtained in combat ships depends upon a number of factors, such as the height of the stack, the use of armor bars, resistances through the blowers, etc., and is no different for boilers of the divided-furnace separately fired superheater type than for any others of similar efficiency characteristics. Although sufficient draft usually is available in such installations to permit operation at extremely low firing rates, it is not customary to do this because of the possibility of the formation of smoke and relatively poor control of the firing conditions.

T. B. STILLMAN.[12]

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[6] Ammonia Department, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del.

[7] Chairman, A.S.M.E. Peninsula Section, Grand Rapids, Mich.

[8] Gasoline Plant Construction Corporation, Houston, Texas. Mem. A.S.M.E.

[9] "Design of Oil-Field Tank Batteries for Conservation," by R. M. Stuntz, Jr., MECHANICAL ENGINEERING, May, 1942, pp. 355–360.

[10] Scientific Department, Consolidated Steel Corporation, Ltd., Shipbuilding Division, Orange, Texas.

[11] "Marine Boilers," by T. B. Stillman, MECHANICAL ENGINEERING, April, 1942, pp. 279–287.

[12] The Babcock & Wilcox Company, New York, N. Y. Mem. A.S.M.E.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Committee Secretary, 29 West 39th St., New York, N.Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of June 19, 1942, except Cases No. 830 (Reopened), No. 968 (Reopened), and No. 971 were formulated by the Executive Committee at a meeting on July 16, 1942, and all were subsequently approved by the Council of the American Society of Mechanical Engineers.

CASE No. 830 (Reopened)

(*Special Ruling*)

Inquiry: Is it permissible, under the A.S.M.E. Power Boiler Code, to attach an internal cylindrical furnace, not exceeding 18 in. in diameter, to the flat heads of a boiler not exceeding 42 in. in diameter and 10 ft in length, by fusion welding after flaring the ends of the furnace beyond the outside face of the heads at an angle of 20 to 30 deg; providing

(1) The distance between the edges of the tubes to the cylindrical furnace does not exceed 2 in.;

(2) The head outside the tube bank is stayed in accordance with the code requirements;

(3) The welding is equivalent to that required under the rules in Pars. P-101 to P-110, omitting radiographing;

(4) The welding is stress-relieved?

Reply: It is the opinion of the Committee that the construction outlined in the inquiry, under the limitations stated, meets the intent of the Code requirements.

CASE No. 968 (Reopened)

Add the following to item (6):

Ellipsoidal heads with flanged-in manholes shall be designed in accordance with the present rules and stresses in the Code.

CASE No. 971

(*Interpretation of Pars. P-105(c) and U-74*)

Inquiry: On the basis of test data submitted, will it be permissible to depart from the requirement of Pars. P-105(*c*) and U-74 and drill tube holes through welded seams which have been radiographed and stress-relieved?

Reply: Based on the evidence acquired from extensive experimental test programs, it is the opinion of the Boiler Code Committee that it will be permissible to suspend the restriction of Pars. P-105(*c*) and U-74 to allow unreinforced holes to be machine-cut through welded seams, and tubes may be rolled and expanded in such holes, provided that in the portion of the welded joints in which such holes are to be cut:

(1) The welds have been satisfactorily radiographed and magnafluxed on both sides and stress-relieved;

(2) The weld shall contain no slag inclusion or defect longer than $0.15t$ (where t is the thickness of the weld) but in no case greater than $^3/_8$ in.;

(3) The joint efficiency as well as the ligament efficiency is considered in calculating the thickness.

CASE No. 973 (*Special Ruling*)

Inquiry: Will pressure parts of boilers and pressure vessels meet the requirements of the Code if fabricated by the oxy-acetylene pressure-welding process where the procedure is qualified by the fabricator by the welding and suitable testing of full-thickness specimens? The welding is accomplished by applying pressure to the abutting surfaces and heating the metal uniformly and rapidly to the upper limits of its plastic temperature range.

Reply: Where the entire joint area is mechanically welded simultaneously under the conditions set forth in the inquiry, this process may be applied to Code constructions for any material provided for in Pars. P-103 and U-71 with the joint efficiency, E, taken as 90 per cent. The fabricator shall qualify his procedure for each type of application and material, by the welding of specimens of the same sectional dimensions, and testing coupons shall be taken therefrom. Two standard 2-in. gage-length tension-test specimens across the center of the section of the joint shall, unless a full-thickness specimen is tested, exhibit tensile and elongation properties not less than the minimum specified for the material welded. Two root-bend specimens across the joint as called for in Pars. UA-38(*h*) or Q-108(*b*) shall also meet the requirements set forth in either paragraph.

CASE No. 974

(*Interpretation of Table P-14*)

Inquiry: Is it necessary to proportion the sizes of openings for safety valves on fire-tube waste heat boilers as required in Table P-14? This table may require areas that are larger than necessary for high-lift (capacity) valves.

Reply: It is the opinion of the Committee that fire-tube boilers used for waste heat purposes only, and which are not equipped for direct firing, need not meet the requirements of Table P-14 with respect to safety valve openings, provided safety valves of the required relieving capacity are furnished by the manufacturer of the waste heat boiler as an integral part of the installation.

CASE No. 975

(*Interpretation of Par. P-299e*)

Inquiry: What pressure ratings may be used for valves and fittings made to comply with the requirements of the American Standard for Steel Pipe Flanges and Flanged Fittings, B16e, but having welding ends instead of flanges?

Reply: It is the opinion of the Committee that valves and fittings otherwise complying with the requirements of ASA B16e, but having welding ends, may be rated at the pressures stated in that Standard for ring joints, and the values so stated in Table P-15 may be used for maximum allowable saturated steam pressures and for maximum allowable boiler pressures for feedline and blow-off service.

CASE No. 976

(*Interpretation of Pars. P-102(h) and U-68(h)*)

Inquiry: Will it be permissible under the Code rules, upon the basis of evidence presented in the use of gamma rays as a source of radiation, to increase the minimum size penetrameter hole from $^1/_{16}$ in. to $^3/_{32}$ in. diameter?

Reply: It is the opinion of the Committee that since the minimum hole diameter was intended primarily for X-rays, it will be permissible when using gamma rays to increase the minimum

diameter to $^3/_{32}$ in. All other dimensions of the penetrameter are to remain the same as now required.

CASE No. 977 (*Special Ruling*)

Inquiry: Is it permissible under the Code requirements to use material complying with A.S.T.M. Specifications A226-40 for Electric-Resistance-Welded Steel Boiler and Superheater Tubes for High-Pressure Service on the same basis as Specification S-32?

Reply: It is the opinion of the Committee that material complying with A.S.T.M. Specifications A226-40 may be used where provision is made for the use of material complying with Specification S-32.

CASE No. 978 (*Special Ruling*)

Inquiry: May material not exceeding $^3/_4$ in. in thickness, produced on sheet or strip mills in accordance with Bureau of Ships Ad Interim Specification 48S5, grade M, welding quality, be used in pressure vessels constructed under Pars. U-69 and U-70?

Reply: It is the opinion of the Committee that for the duration of the war emergency, and until this Case is annulled, the material and the use thereof referred to in the inquiry is acceptable for Code vessels under Pars. U-69 and U-70, provided:

(1) The measured thickness is not less than that required by Code rules;

(2) If plates are delivered without the stampings required by Specification S-1, the stamping shall be applied on the authority of the inspector, based on the heat number appearing on the bundle of plates and the mill test report;

(3) The Code symbol stamp is followed by the letters "NE."

CASE No. 979 (*Special Ruling*)

Inquiry: Due to the present need for conserving critical materials, and the improvements in design, construction, and materials, may the design stresses and joint efficiencies for Pars. U-68 and U-69 vessels be increased over present Code requirements?

Reply: It is the opinion of the Committee that Pars. U-68 and U-69 vessels may be constructed with maximum design stresses given in Table U-2 multiplied by 1.25, and a joint efficiency of 95 per cent for Par. U-68 vessels and 85 per cent for Par. U-69 vessels may be used in the formulas in Pars. U-20(*a*) and (*b*), U-36, and U-59 with the following restrictions:

(1) The ellipsoidal and hemispherical heads and the shells of air, steam, and water vessels, calculated by the rules of this Case, shall be provided with an additive thickness of one sixth of the calculated thickness, but which need not exceed $^1/_{16}$ in., in order to allow for corrosion. Vessels in other corrosive services shall be provided with appropriate corrosion allowances;

(2) These increased design stresses may be used only for hemispherical or ellipsoidal heads. Dished heads, other than hemispherical or ellipsoidal, designed in accordance with the present Code rules, may be used with shells which are constructed in accordance with the rules of this Case. Ellipsoidal heads with flanged-in manholes shall be designed in accordance with the present rules and stresses in the Code.

(3) Excessive stress concentration due to sharp re-entrant angles or abrupt changes in section shall be minimized in design;

(4) Stresses due to hydrostatic head alone, and other stresses which appreciably increase the average stress over substantial sections of shell or head above the allowable design stress, shall also be considered in determining the thicknesses used in construction;

(5) Large temperature differentials in heads or shells shall be avoided or the effect reduced by shields or other suitable means;

(6) All stays, braces, and parts requiring staying, and flanges shall be calculated by the present rules;

(7) In computing the maximum size of an unreinforced opening under Par. U-59 (*a*), K in the formula and the diagrams shall equal the ratio of computed stress in the solid plate to one fifth of the minimum of the tensile strength of the steel forming the shell or head. Where K is greater than unity, the maximum size of an unreinforced opening shall be 2 in.

Pars. U-68 and U-69 vessels constructed in accordance with the requirements of this Case and other applicable Code rules are considered safe and shall be stamped in accordance with Par. U-66, the Code symbol to be followed by the letters "NE," which also shall be shown on the manufacturer's data report.

This Case shall be effective until it is annulled, revised, or Code revisions made.

CASE No. 980

(*Interpretation of Tables U-2, U-2$^1/_2$, P-7, and P-5*)

Inquiry: Tables U-2, U-2$^1/_2$, P-7, and P-5 contain allowable stresses for other than silicon-killed carbon steel (silicon less than 0.10 per cent) up to 950 F, no stresses being shown for 1000 F. In view of the present emergency and the fact that carbon steel of this description has been in successful service in many instances, it is requested that the Committee consider the advisability of assigning stress values at 1000 F for this material.

Reply: It is the opinion of the Committee that an allowable stress of 1350 lb per sq in. at 1000 F may be used for other than silicon-killed carbon steels (silicon less than 0.10 per cent) for all plate, pipe, tubes, forging and casting materials for which allowable stresses are now shown up to 950 F in Tables U-2, U-2$^1/_2$, P-7, and P-5.

CASE No. 981(*Special Ruling*)

Inquiry: Is it permissible to use the following A.S.T.M. Emergency Alternate Provisions affecting existing Code specifications: EA-A 27 (S-11), EA-A 194 (S-51), EA-A 216 (S-56), EA-A 217 (S-57) EA-A 240 (S-62), EA-B 62 (S-46)?

Reply: It is the opinion of the Committee that the above-mentioned A.S.T.M. Emergency Alternate Provisions in the corresponding Code specifications may be considered as meeting the intent of the Code.

CASE No. 982 (*Special Ruling*)

Inquiry: Where specifications for plate material permit plates to be furnished not more than 0.01 in. thinner than ordered, is it necessary to take account of the reduced thickness in the application of the Code rules?

Reply: It is the opinion of the Committee that plate material that is not more than 0.01 in. thinner than that calculated from the formula will meet the intent of the Code.

Revisions and Addenda to Boiler Construction Code

PROPOSED revisions of the Rules for Bolted Flanged Connections were published in the February, 1942, issue of MECHANICAL ENGINEERING (pages 146 to 149) for comment. As a result of comments received, and further consideration given to these revisions by the Special Committee on Rules for Bolted Flanged Connections, recommendations have been received for modifications and additions of these proposed revisions, including a revision of Par. UA-19. This new material was received too late to make possible its complete inclusion in this issue. However, all interested parties may obtain a copy of the proposed changes by addressing the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., for purposes of commenting thereon. The Committee requests that all comments be received by the Secretary not later than thirty days after publication.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Technical Program for A.S.M.E. Fall Meeting at Rochester, N. Y., October 12–14, Has Direct Bearing on Production for Victory

The Hon. Humphrey Mitchell, Canadian Minister of Labor, to Speak

WHILE not complete in every detail the technical program for the A.S.M.E. Fall Meeting in Rochester, N. Y., Oct. 12–14, is sufficiently advanced to permit of announcing the technical papers and their authors as well as many of the nontechnical events. It bears out the statement made in our last issue that essentially this meeting is an engineering conference on production for victory. There are few sessions which do not have a direct bearing on the war effort of this country—and therefore every member of The American Society of Mechanical Engineers who can possibly spare a day in attendance will feel that his time is being profitably spent.

Of importance also will be the meeting of the Executive Committee of the Council of the Society and the meeting of the Local Section delegates from Group III who will hold their official conference during the convention.

The experience of the Society in the last war indicated that members availed themselves of opportunities at similar meetings to discuss urgent problems with their fellow engineers—in fact, the attendance records of those years were far greater than they have been at any time since then. Therefore members are urged to make early reservations for rooms during the Rochester Fall Meeting because both its location and its program are such as to give promise of a record crowd.

Courtesy Rochester Chamber of Commerce

UNIVERSITY OF ROCHESTER MAIN QUADRANGLE WITH THE RUSH RHEES LIBRARY IN CENTER

Headquarters at Sagamore

The Meeting and registration headquarters will be at the Sagamore Hotel, on East Avenue, which has been refurnished and redecorated during the last year and offers comfortable and attractive accommodations. Other hotels in the city include the Seneca, the Rochester, and the Cadillac.

Plant Trips

Rochester is the home of some of the largest plants in the world in their respective fields and the city abounds in industrial, educational, and other points of interest. The Rochester Committee has provided a list of plants which may be visited either by groups of members who are citizens or in some cases by special arrangement as individuals whose particular interest in the processes and products of that particular organization will serve in similar war efforts. In general, therefore, it may be said that trips are being planned to plants not engaged in essential work for war production. However, there will be trips to plants whose methods may be of help to A.S.M.E. members engaged in similar work as an aid to greater all-around efficiency.

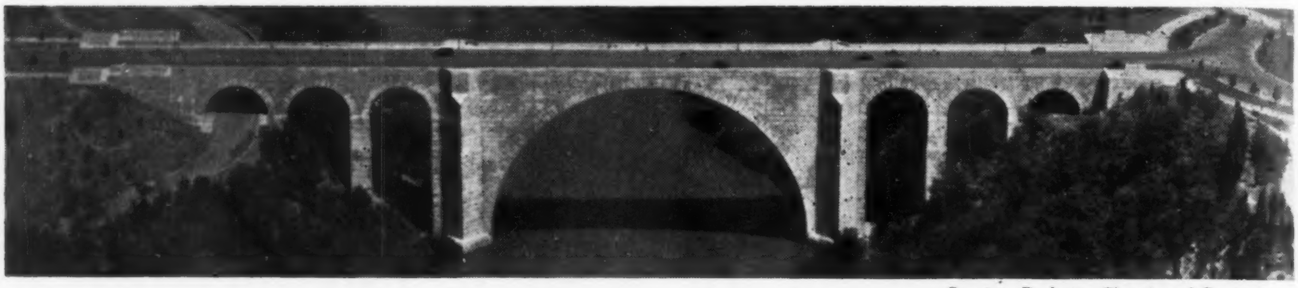
Because of war conditions these trips, while taboo, must be handled with every precaution to guard against interruption of activities. The trips will be restricted to A.S.M.E. members who are United States' citizens. *All members are therefore urged to register IMMEDIATELY for these trips*, indicating their interest in Rochester industries. Do this now even though you may not be positive of attending. It is easier to cancel a reservation than to make one at the eleventh hour. A blank for this purpose will be found on page 62 of the advertising section of this issue.

The Honorable Humphrey Mitchell to Speak

Social gatherings will be provided through luncheons on each of the three days of the Meeting and a banquet on Tuesday evening with such outstanding speakers as the Honorable Humphrey Mitchell, Canadian Minister of Labor, James W. Parker, president A.S.M.E., and Igor Sikorsky, engineering manager of Vought-Sikorsky Aircraft.

Technical Program

The technical program for the Meeting has been developed with painstaking effort by the A.S.M.E. Professional Divisions and committees and its details which follow are convincing proof of its value and importance at this particular time.



Courtesy Rochester Chamber of Commerce

THE VETERAN MEMORIAL BRIDGE SPANNING THE GENESEE RIVER—A LANDMARK OF ROCHESTER

A.S.M.E. 1942 Fall Meeting Program

Rochester, N. Y., October 12–14

Headquarters, Sagamore Hotel

SUNDAY, OCTOBER 11

9:30 a.m.

Conference of Sections' Delegates, Group III Committee Meetings

2:30 p.m.

Meeting Executive Committee with Representatives of the Council

6:30 p.m.

Dinner Council and Committees

8:00 p.m.

Get-Together Council and Committees

MONDAY, OCTOBER 12

9:30 a.m.

Wood Industries (I)

The Effect of Wood Structure Upon Heat Conductivity, by Frederick F. Wangaard, University of Washington, Seattle, Wash.

Making Plywood With Multidirectional Pressure, by John S. Barnes, president, Skaneateles Boats, Inc., Skaneateles, N. Y.

High-Density Plywood, by Malcolm Finlayson, Central Technical Laboratory, Armstrong Cork Co., Lancaster, Pa.

Education and Training (I)

What Can Be Done to Train Women for Engineering Jobs, by Robert H. Baker and Mrs. O. S. Reimold, War Industries Training School, Stevens Institute of Technology

Women in Engineering, Lillian M. Gilbreth, president, Gilbreth, Inc., Bloomfield, N. J.

12:30 p.m.

Reception—Luncheon

2:30 p.m.

Plant Trips

Fuels

Performance of Rod Curtain Type Electrostatic Precipitators, by Irvin G. McChesney, test engineer, Rochester Gas & Electric Corporation, Rochester, N. Y.

MONDAY, OCTOBER 12

(*continued*)

Wood Industries (II)

Factors Responsible for Raised Grain Following Sanding and Staining, by George Marra, graduate student, N. Y. State College of Forestry, Syracuse, N. Y.

Vibration Studies on Normal- and High-Density Plywood, by Albert Dietz, professor, Massachusetts Institute of Technology, Cambridge, Mass., and Henry Grinsfelder, Resinous Products & Chemical Co., Inc., Philadelphia, Pa.

The Use of High-Frequency Fields for the Cure of Resin Adhesives in Making Plywood and Laminated Wood Products, by J. P. Taylor, Transformer Sales Division, Radio Corporation of America, Camden, N. J.

Aviation I

Modern Tricycle Landing Gear, by G. M. Magnum, assistant chief engineer, Houde Engineering Division of Houdaille-Hershey Corporation, Buffalo, N. Y.

Design-Strengthened Sheet and Strip for Aircraft Construction, by R. S. Smith, vice-president, Rigid-Tex Corporation, Pittsburgh, Pa.

8:00 p.m.

Education and Training (II)

Panel Discussion on Education for Industry
Discussion Leaders:

Carl L. Bausch, *Chairman*

Mark Ellingson	R. L. Goetzenberger
S. C. Hollister	L. J. Fletcher
Verne Bird	M. J. Kane
Ralph C. Welch	E. J. Pelletier

Aviation—Production Engineering

Bevel Gear as Used in Aircraft, by A. H. Candee, Gleason Works, Rochester, N. Y.

Production Methods at Bell Aircraft, by M. Stupar, co-ordinator of production, Bell Aircraft Corporation, Buffalo, N. Y.

MONDAY, OCTOBER 12

(*continued*)

A Theoretical Analysis of a Constant Speed, Counter-rotating Propeller, by Otto J. V. Dunhofer, Rensselaer Polytechnic Institute, Troy, N. Y. (presented by P. E. Hemke)

Power—Applied Mechanics

The Elastic Properties of Curved Tubes, by Irwin Vigness, Naval Research Laboratories, Washington D. C.

Elimination of Carry-Over Under Steel-Mill Operating Conditions, by H. M. Rivers, chemical engineer, Hall Laboratories, Inc., Pittsburgh, Pa., and William P. Hill, steam engineer, Bethlehem Steel Co., Sparrows Point, Md.

TUESDAY, OCTOBER 13

9:30 a.m.

Production Engineering (I)

Symposium on Heavy Machine Tools

Photocopying Methods in Engineering, by C. D. Pate and E. C. Jewett

Management (I)

Women in Industry

From the Theoretical Standpoint, by Leonard Greenburg, M.D., executive director, Division of Industrial Hygiene, State of New York, New York, N. Y.

From the Practical Standpoint, by L. L. Park, superintendent of welfare, American Locomotive Co., Schenectady, N. Y.

Industrial Instruments and Regulators

Process Lags in Automatic-Control Circuits, by J. G. Ziegler, sales engineering department, Taylor Instrument Cos., Rochester, N. Y., and N. B. Nichols, Massachusetts Institute of Technology, Cambridge, Mass.

12:30 p.m.

Luncheon

TUESDAY, OCTOBER 13
(*continued*)

2:00 p.m.

Plant Trips

6:30 p.m.

Banquet

Speaker: Hon. Humphrey Mitchell, Canadian Federal Minister of Labor

WEDNESDAY, OCTOBER 14

9:30 a.m.

Management (II)

Industrial Salvage

Supporting the War Effort by Conserving the Use of Critical Materials

Handling Scrap After It Has Been Produced, by Robinson D. Bullard, reclamation engineer, Bullard Co., Bridgeport, Conn.

Production Engineering (II)

Precision Jigs and Fixtures, by Arthur Simon, engineer, Eastman Kodak Co., Rochester, N. Y.

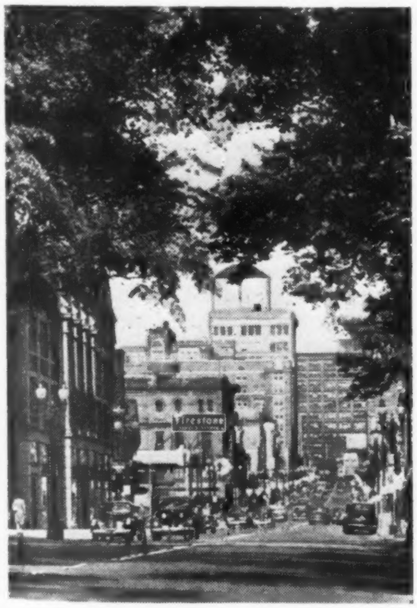
Optical Devices in the Machine Shop, by Claude McCathron, Bausch & Lomb Co., Rochester, N. Y.

Materials Handling

Material Handling Methods in the War Production Program, by A. F. Anjeskey, sales manager, Cleveland Tramrail Division, Cleveland Crane & Engineering Company, Wickliffe, Ohio

2:00 p.m.

Plant Trips



BEAUTIFUL EAST AVENUE IN ROCHESTER LOOKING TOWARD MAIN STREET

(One of the oldest streets in the city; the lower half houses the city's exclusive shops while further out are some of its most beautiful homes.)

Cushing

A BUSY CORNER IN ROCHESTER WITH STREAMLINED BUSSES VERY MUCH IN EVIDENCE

Actions of A.S.M.E. Executive Committee

Meeting in Society Headquarters on July 21

THE Executive Committee of the Council of The American Society of Mechanical Engineers met at the Society headquarters in New York, N. Y., on July 21, 1942. President James W. Parker presided, and there were present, Clarke F. Freeman, vice-chairman, G. E. Hulse and C. B. Peck, of the Committee; J. N. Landis (Local Sections); W. D. Ennis, treasurer; H. V. Coes, nominee for president, 1943; C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary. The following actions were of general interest.

Boston Employment Office

It was reported that the Engineering Societies Personnel Service, Inc., had opened an office in Boston, June 1, 1942, the fifth now being operated by the Service. The Boston office will be entirely staffed by the E.S.P.S. Bureau Personnel and the policies to be followed will be the same as those followed by the other offices. A local advisory committee, made up of representatives of the Founder Societies, the Engineering Societies of New England, the Boston Society of Architects, and two representatives of the Emergency Planning and Research Bureau, Inc., has been formed.

Cottonseed Processing

Upon recommendation of the Research Committee it was voted to discharge, with appreciation for its work, the Special Research Committee on Cottonseed Processing.

Standardization

Confirmation was voted of letter-ballot approval of the recommendation of the Standardization Committee that a special committee on the standardization of therbligs, process charts, and their symbols be organized.

Approval was voted of two standards: (1) Proposed American Standard for Welding Symbols and Instructions for Their Use and (2) proposed revision of the American Standard for Graphical Symbols for Telephone, Telegraph, and Radio Use.

Communication for "Members' Page"

The Executive Committee noted the communication of July 18, 1942, from Gregory M. Dexter in which he presented his disagreement with the action of the Council on the disposal of his paper dealing with a case study of electrical rates and service in a suburban community and in which he asked for space in the October issue of MECHANICAL ENGINEERING for statement of his criticisms. The Executive Committee noted the fact that the Members' Page was instituted by past-president William L. Batt to provide for just such presentations of opinions. No action was necessary, therefore, on the part of the Executive Committee and the Secretary was instructed to convey this information to Mr. Dexter and express the wish that this statement would be kept within reasonable limits.

Deaths

The Committee noted with deep regret the death, on June 16, 1942, of W. Lyle Dudley, manager and vice-president of the Society, 1935–1938 and 1938–1940, respectively; and, on July 5, 1942, of H. G. Reist, manager and vice-president of the Society, 1909–1912 and 1913–1915, respectively.

Appointments

The following appointments of members to serve on Society committees, or as Society representatives, were reported for the record:

Committee on Constitution and By-Laws, S. R. Beitler, to fill the unexpired term of L. H. Kenny, to December, 1943.

Committee on Education and Training for the Industries, as advisory members, Lillian M. Gilbreth and John I. Yellott.

Special Research Committee on Furnace Per-

formance Factors, A. J. Nerad, J. R. Michel (alternate for A. D. Bailey), W. C. Schroeder (alternate for A. C. Fieldner).

Special Committee on Standardization of Therbligs, Process Charts, and Their Symbols. David B. Porter, chairman, R. W. Allen, R. M. Barnes, C. H. Cox, Lillian M. Gilbreth, J. M. Juran, H. B. Maynard, and J. A. Piacitelli.

E.C.P.D. Committee on Engineering Schools Delegatory Committee, Region VI, Earl D. Hay.

Engineering Foundation, Research Procedure Committee, W. Trinks, to October, 1943.

Daniel Guggenheim Medal Board of Award, John E. Younger (three years).

National Research Council, Division of Engineering and Industrial Research, E. G. Bailey (three years).

College of the City of New York, inauguration of Dr. Harry Noble Wright as president, Sept. 30, 1942, Roy V. Wright and H. V. Coes.

The Engineer at War!

ON page 638 of the August issue of MECHANICAL ENGINEERING mention was made of a series of eleven radio programs being broadcast by NBC dealing with the contributions of engineers to the prosecution of the war. The series started on July 16 and runs through to September 24.

The earlier broadcasts on Blackouts, Bombs, Resistance of Structures, The Naval Engineer, Dry Docks and Ship Repair Bases, Tanks and Tools went on the air as scheduled and were well presented and received.

Requests for copies of scripts were received from air-raid wardens and others interested in having the latest authentic statement on how to treat incendiary bombs. The broadcast was the first official statement on the use of a heavy jet rather than a spray of water.

Remaining broadcasts are scheduled over WEAF at 6:30 p.m. on Thursdays as follows:

Aug. 27 Airplanes.
R. F. Gagg, A.S.M.E., assistant to general manager, Wright Aeronautical Co., Paterson, N. J.
T. P. Wright, War Production Board, Washington, D. C.

Sept. 3 Petroleum Production.
Dr. Robert E. Wilson, president, Pan American Petroleum Co.

Sept. 10 Power—Water, Steam, Electric.
Glenn B. Warren, A.S.M.E., General Electric Co., Schenectady, N. Y.
John P. Hogan, A.S.C.E., past-president, American Society of Civil Engineers
Philip Sporn, A.I.E.E., vice-president and chief engineer, American Gas and Electric Service Corporation, New York, N. Y.

Sept. 17 The U. S. Engineers' Corps in Peace and War, by U. S. Engineers' Corps.

Sept. 24 Communications in Action.

R. L. SACKETT, *Chairman*
Subcommittee on Program Committee on Radio Talks on Engineering Subjects of A.S.C.E., A.I.E.E., A.S.M.E., A.I.M.E., and A.I.Ch.E.

Joint A.S.M.E.-A.I.M.E. Fuels Conference Directed To War Effort

St. Louis, Mo., Sept. 30–Oct. 1

"THERE are few plants in this country that will not encounter some form of fuel problem because of conditions which arise from the war," writes Ollison Craig, engineering manager of the Riley Stoker Corporation, in his paper to be delivered before the sixth annual meeting of the Fuels Division of the A.S.M.E. and the Coal Division of the A.I.M.E. at St. Louis, Mo., September 30–October 1, 1942.

While Mr. Craig's paper does not attempt to cover all of the problems that will be encountered with fuel, it does point out the more frequent ones and indicates a solution for them. And so it is with practically all of the papers on this wartime program—each in its field is taking up some special topic of immediate concern and giving able attention to the best way of handling the matter.

These joint fuel conferences since their beginning in 1937 have attracted the experts in this field and with each successive meeting, the attendance has grown, the papers have been more widely sought, and the resulting good more gratifying.

Conference to Tie in With A.I.M.E. Regional Meeting

This year the Joint Fuels Conference is being held during the Regional Meeting of the A.I.M.E. which will result in greater numbers being able to attend both conventions without having to make two trips, an arrangement that seems an unusually happy one in a year when time is at a premium.

These combined groups of the A.S.M.E. and A.I.M.E. have an unusual facility for arranging a program that mixes good tough mental gymnastics with enough fellowship to put the sessions over with a bang—all crowded to the doors. There are no dull minutes at a Fuels Conference, and as a proof of that read the program and note the papers lined up for presentation.

Percy Nicholls Award Banquet

At the banquet of the two Divisions on Wednesday evening the first Percy Nicholls Award will be made "for notable scientific or industrial achievement in the field of solid fuels." While the name of the recipient may not be divulged at this writing, it will make the occasion one of outstanding importance. The Coal and Fuels Divisions of the two organizations are thus perpetuating the name of Mr. Nicholls who died on February 12 of this year, and who since 1925 served as supervising engineer of the Fuels Section of the Bureau of Mines. Mr. Nicholls was the author of more than fifty papers on technical subjects and was an outstanding contributor to the literature on solid fuels. His papers on the fundamentals of combustion were accepted as classics. He was a member of the A.S.M.E. and had served on many of its committees.

A. R. Mumford, representing the A.S.M.E., will serve as chairman at the banquet, Julian E. Tobey, A.I.M.E., will be toastmaster, and Eugene McAuliffe, president of the A.I.M.E., will make the presentation.

For those who are able to stay the full two days of the meeting there will be an opportunity to attend the banquet of the A.I.M.E. on Thursday evening, October 1, when the Honorable Harold Ickes, Secretary of the Interior, will be the speaker.

Headquarters at Statler

The Hotel Statler will be the headquarters for both the Fuels Conference and the regional meeting of the A.I.M.E. Make your reservations now.

The detailed program follows.

Program

WEDNESDAY, SEPTEMBER 30

8:00 a.m. Authors' and Chairmen's breakfast

9:00 a.m. Registration

9:30 a.m.

Address of Welcome, by Dr. M. M. Leighton, Illinois Geological Survey, Urbana, Ill.

Reply by A. R. Mumford, Combustion Engineering Company, New York, N. Y.

Morning Session

10:00 a.m.

Cochairmen: Martin A. Mayers, Coal Research Laboratory, Carnegie Institute of Technology, and Dr. Frank H. Reed, Illinois Geological Survey, Urbana, Ill.

Increasing the Percentage Production of Large-Size Coke at Fast Coking Rates to Meet Wartime Demands, by I. M. Roberts, Laclede Gas Light Co., St. Louis, Mo.

Plan to Improve Blast-Furnace Coke, by W. T. Brown, research engineer, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

12:30 p.m. Joint Luncheon

Presiding: Newell G. Alford

Reports of Committees

Afternoon Session

2:00 p.m.

Cochairmen: R. A. Sherman, Battelle Memorial Institute, Columbus, Ohio, and Carl T. Hayden, Sahara Coal Company, Chicago, Ill.

Density Index Patterns of the Physical Characteristics of Ash and Clinkers From Coal

and Admixtures, by R. M. Weimer, Northern Illinois Coal Corp., Wilmington, Ill.
Some Ways to Avoid High Stoker Maintenance and Inefficient Combustion, by A. R. Mumford, Combustion Engineering Co., New York, N. Y.
The Distribution of Coal Dust by Tank Car as Pulverized Fuel, by Harmon C. Ray, Carter Coal Company, New York, N. Y.

4:45 p.m.

Joint Committee Meeting of Executive Committee of Coal Division A.I.M.E. and Executive Committee of Fuels Division A.S.M.E.

7:00 p.m.

Percy Nicholls Award Presentation Banquet
Chairman: A. R. Mumford
Toastmaster: Julian E. Tobey, Upper Monongahela Valley Association
Presentation of award by Eugene McAuliffe, president, A.I.M.E.
Address by recipient of Award

THURSDAY, OCTOBER 1

8:00 a.m.

Authors' and Chairmen's Breakfast

Morning Session

9:30 a.m.

Cochairmen: A. R. Mumford, Combustion Engineering Company, New York, N. Y., and V. G. Leach, Peabody Coal Co., Chicago, Ill.
Combination Coal and Gas Firing, by H. L. Crain, Kansas City Power & Light Co.
Use of Mixtures of Oil and Coal in Boiler Furnaces, by W. C. Schroeder, United States Bureau of Mines, College Park, Md.

12:30 p.m.

Joint Luncheon—all divisions participating
Presiding: Carl Stiefel, Eugene McAuliffe, and W. M. Jeffers, president, Union Pacific Railroad

Afternoon Session

2:00 p.m.

Cochairmen: W. Voskuil, Illinois State Geological Survey, Urbana, Ill., and A. W. Thorson, Carnegie Institute of Technology, Pittsburgh, Pa.
Priorities in Mine Supplies and Mining Equipment, by D. L. McElroy, University of West Virginia
Meeting Wartime Fuel Problems, by Ollison Craig, Riley Stoker Corporation, Worcester, Mass.
Using Machine Shops for War Production, by A. Lee Barrett, Pittsburgh Coal Company, Pittsburgh, Pa.

7:00 p.m.

Regional Meeting Banquet
Presiding: Eugene McAuliffe, president, A.I.M.E.
Speaker: Hon. Harold L. Ickes, Secretary of the Interior
Four-minute talk by Dr. Bordin S. Veeder, chairman of the St. Louis Red Cross Chapter

Friday, October 2

8:00 a.m. Inspection Trips

MEMBERS OF AMERICAN INDUSTRIES SALVAGE COMMITTEE
(Left to right: Oliver E. Mount, R. S. Wilson, Robert W. Wolcott, chairman, and Charles R. Hook, vice-chairman.)

American Industries Salvage Committee Is Organized

FORMATION of the American Industries Salvage Committee, representing groups of leading industrial concerns who are working with the Conservation Division of the War Production Board to help speed the collection of vital scrap materials, has been announced by Robert W. Wolcott, chairman of the group and President of Lukens Steel Company.

Other members of the administrative committee directing the nation-wide $2,000,000 campaign are: Charles R. Hook, president of the American Rolling Mill Company, vice-chairman; R. S. Wilson, representing Rubber Manufacturers Association; and O. E. Mount, representing Steel Founders' Society of America.

Work to Be Twofold

The work of the committee, backing up a broad advertising program, will be twofold: (1) To reach every manufacturing and business firm in the nation to impress upon them the absolute necessity of getting their scrap on the way to the production line; and (2) to get businessmen to co-operate with the local salvage committees of W.P.B. already set up in 12,000 communities.

The activities of the committee will be closely co-ordinated with the present intensified scrap-collection drive of the WPB, according to Mr. Wolcott. In this connection, the committee is underwriting the cost of an extensive national advertising campaign approved by the War Production Board, with a number of major industries underwriting the costs.

The advertising being carried on in newspapers, magazines, farm and trade papers, and on the air, focuses the spotlight of public attention upon the need for iron and steel scrap, nonferrous metals, rags, burlap, rubber, tin cans (in some localities), and waste cooking fats.

Industrial Leaders Chairmen

Supplementing contacts with industry already established by the Industrial Salvage Division of W.P.B., the American Industries Salvage Committee will make a direct approach to individual industrial concerns, working through industry chairmen who are now being appointed. Leaders in fifty industries are being asked to serve as chairmen for their respective trades in a broad effort to see that every company appoints a salvage manager with authority not only to clean out production scrap but also to junk obsolescent equipment and similar material.

A Practical Text on Turbine Performance

MEMBERS of the power industry should not neglect the opportunity to add the 1941 A.S.M.E. Test Code for Steam Turbines to their reference collection. For in addition to providing detailed recommendations for performance testing of all modern types of steam turbines and the instructions for making the necessary pressure, temperature, and flow measurements, the Code contains comprehensive instructions on making corrections to test performance, the terms and symbols applicable to all types of turbines, a check list which provides for such items as (1) maintaining standard test conditions, (2) methods of measuring steam flow, (3) determination of correction factors, (4) preliminary runs, (5) instruments and apparatus for measurement of mechanical and electrical output, and (6) computation of results.

The Code is obtainable from the A.S.M.E. Publication-Sales Department. Price $2.50; 20 per cent discount to A.S.M.E. members.

Do You Know Members Who Are Prisoners of War?

IF YOU do know of any A.S.M.E. members who are prisoners of war and also where they are being held, send their names to A.S.M.E. headquarters. Through a special arrangement with a service organization, copies of the A.S.M.E. publications licensed for export abroad may be sent to them.

Exhibit of Taylor-White Development of High-Speed Tool Steels Presented to Smithsonian by Bethlehem Steel

AN interesting exhibit commemorating the Taylor-White development of high-speed tool steels was recently built by Bethlehem Steel Company and presented to the Smithsonian Institution in Washington, D. C.

In 1898 Frederick W. Taylor, past-president of the American Society of Mechanical Engineers, well-known industrial counselor and the originator of the Taylor system of industrial management, and Maunsel White, metallurgist of Bethlehem Steel Company, carried out a series of experiments at Bethlehem, Pa., during which they discovered an entirely new type of tool steel. Their work led to a new art—high-speed turning and cutting—which was soon to revolutionize the entire machine-tool industry.

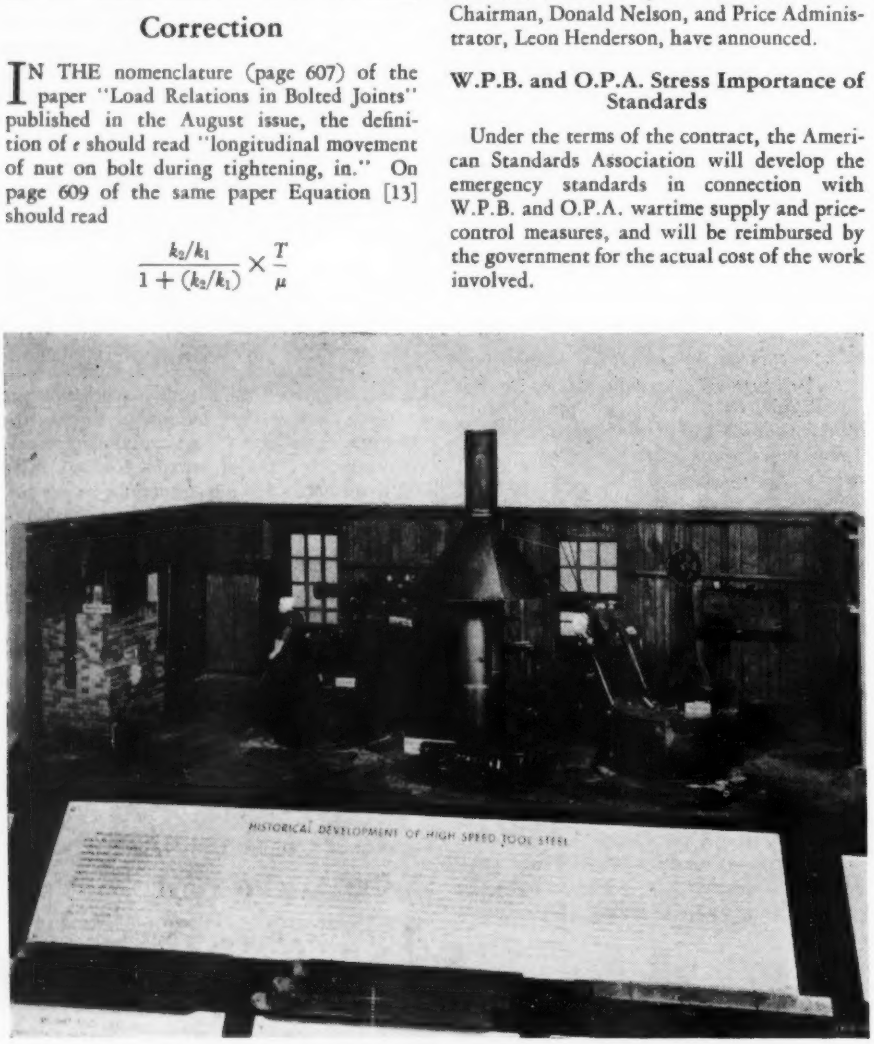
The main feature of the exhibit is a small-scale reproduction of the original Taylor-White laboratory in Bethlehem, with replicas of their lathe, heating furnaces, heat-treating furnaces, and the optical thermometer constructed for this test, one of the first of this type used in metallurgical work. Some of the original tools made by Taylor and White, the stamp used for marking their products, and specimens of other tool steels of the period are also included.

The exhibit contains much factual data about the process, several books written by Mr. Taylor, a copy of the slide rule for rapid calculation of cutting feed, speed, and depth developed by C. G. Barth, a prominent mathematician associated with Mr. Taylor for many years. Many interesting photographs are also on display.

Correction

IN THE nomenclature (page 607) of the paper "Load Relations in Bolted Joints" published in the August issue, the definition of e should read "longitudinal movement of nut on bolt during tightening, in." On page 609 of the same paper Equation [13] should read

$$\frac{k_2/k_1}{1 + (k_2/k_1)} \times \frac{T}{\mu}$$



SMALL-SCALE REPRODUCTION OF ORIGINAL TAYLOR-WHITE LABORATORY IN BETHLEHEM

Contract Between Government and A.S.A. to Make Price Control More Effective

Emergency Standards to Be Developed for W.P.B. and O.P.A.

DEVELOPMENT of standards which will save materials, make fuller use of the nation's production facilities, and make price control more effective by pegging prices to quality will be spurred by a new contract between the government and the American Standards Association, War Production Board Chairman, Donald Nelson, and Price Administrator, Leon Henderson, have announced.

W.P.B. and O.P.A. Stress Importance of Standards

Under the terms of the contract, the American Standards Association will develop the emergency standards in connection with W.P.B. and O.P.A. wartime supply and price-control measures, and will be reimbursed by the government for the actual cost of the work involved.

The increasing importance of standards for pegging the price of goods to their quality has been pointed out recently by Mr. Henderson in connection with the enforcement of price control. Similarly, Mr. Nelson has referred to the importance of standardization and simplification in connection with the program to concentrate civilian production, now being studied by W.P.B. Used in this way, standards can help conserve resources or materials, man power, production, and distribution for essential war purposes.

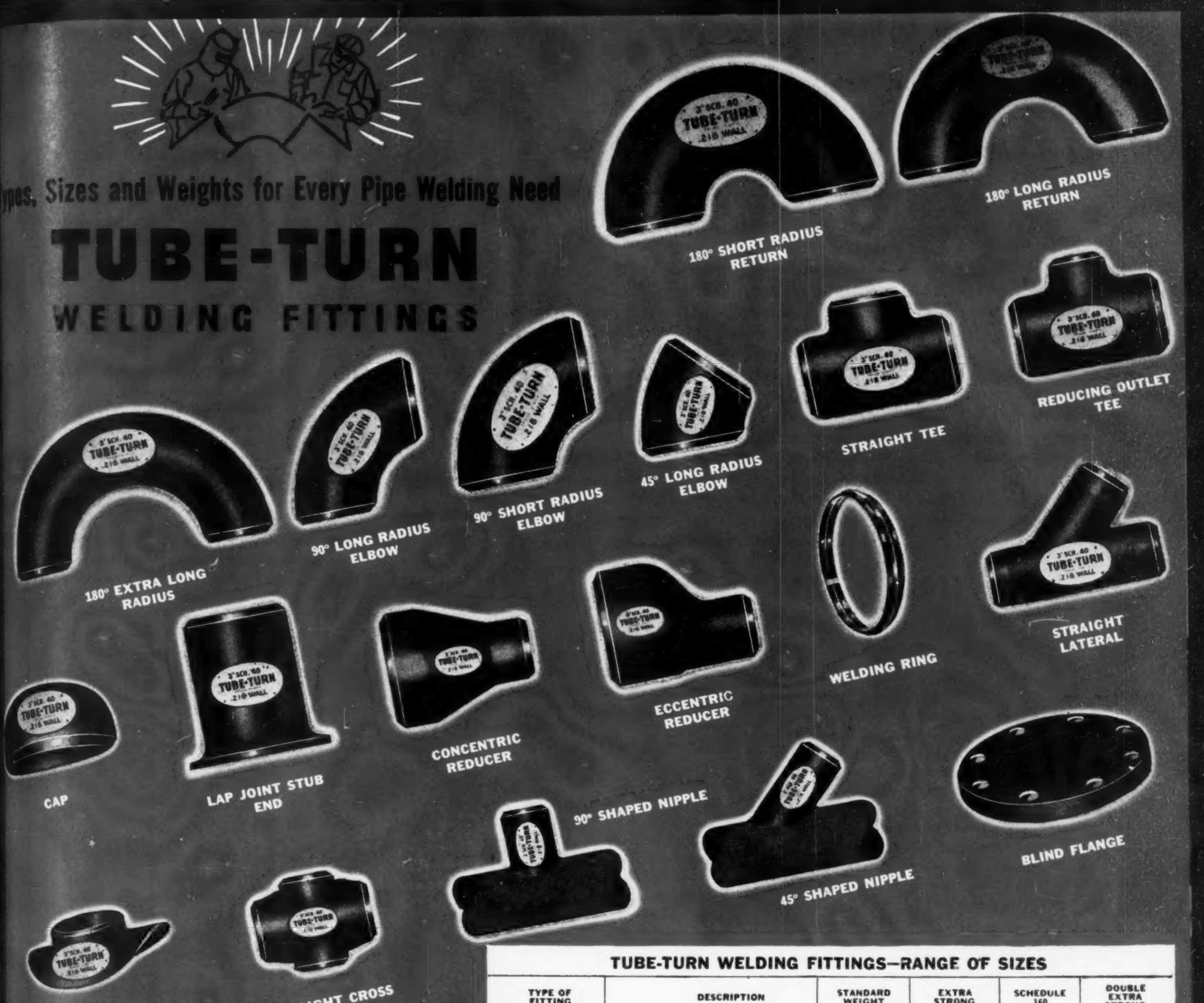
The American Standards Association is a federation of 77 national technical and trade associations and government departments. Among the 10 governmental members are the Army, the Navy, the Department of Commerce (of which the National Bureau of Standards is a part), and the Department of Agriculture. American Standards are developed through the work of hundreds of committees comprising 3000 specialized technical experts representing manufacturers, distributors, and civilian and industrial consumers.

New Machine-Tool Electrical Standards

The A.S.A. has announced the completion of another American War Standard—Machine-Tool Electrical Standards. Proposals for this work were brought to the A.S.A. by the National Machine Tool Builders' Association. Its purpose is to further speed the manufacture of machine tools by standardizing the electrical wiring of such tools. The standard has already been made mandatory by War Production Board Order L-147, which limits the future electrification of machine tools to the types of equipment recommended in the American War Standard. According to the W.P.B., "the standard has been found to provide satisfactory electrification for most purposes, and only under special conditions will machine-tool builders be authorized to produce tools which do not comply with these specifications."

Copies of "Machine Tool Electrical Standards" may be obtained from the American Standards Association, 29 West 39th Street, New York, N. Y., at 40 cents a copy.

(*A.S.M.E. News continued on page 690*)



TUBE-TURN WELDING FITTINGS—RANGE OF SIZES

TYPE OF FITTING	DESCRIPTION	STANDARD WEIGHT	EXTRA STRONG	SCHEDULE 160	DOUBLE EXTRA STRONG
ELBOWS	90° LONG RADIUS	½"-24"	¾"-24"	1"-12"	1"-8"
ELBOWS	90° SHORT RADIUS	1"-24"	1½"-24"		
ELBOWS	45° LONG RADIUS	½"-24"	¾"-24"	1"-12"	1"-8"
RETURNS	180° LONG RADIUS	½"-24"	1"-24"	1"-12"	3"-8"
RETURNS	180° SHORT RADIUS	1"-24"	1½"-24"		
RETURNS	180° EXTRA LONG RADIUS	1"-2½"	1"-2½"		
TEES	STRAIGHT	¾"-24"	¾"-24"	1"-12"	1"-8"
TEES	REDUCING OUTLET	¾"-24"	¾"-24"	1"-12"	1"-8"
REDUCERS	Concentric and Eccentric	1x⅜"-24x20"	1x⅜"-24x20"		1x⅜"-12x10"
CAPS		1"-24"	1"-24"		1"-24"
STUB ENDS	LAP JOINT	1"-24"	1"-24"		
NIPPLES	Shaped, 90° or 45° to Header	1¼"-12"	1¼"-12"		
SADDLES		2"-24"			
LATERALS		1¼"-24"	1¼"-24"		
CROSSES		1¼"-24"	1¼"-24"		
RINGS		¾"-12"	1¼"-12"		
		150, 300, 400†, 600 and 900* Lb.		1500 Lb.	2500 Lb.
FLANGES	WELDING NECK	½"-24"		½"-24"	½"-12"
FLANGES	SLIP-ON	½"-24"		½"-12"	½"-12"
FLANGES	LAP JOINT	½"-24"		½"-24"	½"-12"
FLANGES	THREADED	½"-24"		½"-12"	½"-12"
FLANGES	BLIND	½"-24"		½"-24"	½"-12"

† Dimensions on sizes thru 3½" same as for 600 lb. flanges.
* Dimension on sizes thru 2½" same as for 1500 lb. flanges.

For sizes of light gauge and super-weight fittings, forged steel flanges, and for complete specifications on all Tube-Turn fittings, refer to *Tube-Turn Catalog.*

TUBE-TURN *Welding Fittings*

TRADE MARK

The FIRST WELDING FITTINGS 1ST AND STILL THE BEST

TUBE TURNS, INC., LOUISVILLE, KY. *Branch offices:* **New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Tulsa, Houston, Los Angeles, Washington, D. C.** *Distributors in all principal cities.*

Engineering Societies Personnel Service, Inc.,

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient, nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Boston, Mass.	Chicago	Detroit	San Francisco
29 W. 39th St.	4 Park St.	211 West Wacker Drive	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

GENERAL ASSISTANT TO EXECUTIVE, mechanical-engineering graduate, draft-exempt, with record of success in machinery industry in application engineering, product development, patent experience, budgeting and pricing with inventory control, collections, relations with competitors and creditors, foreign and domestic selling and management, internal and external publicity. Can be of immediate help to overburdened executives. Me-769.

INDUSTRIAL ENGINEER with knowledge of machine tools, conversion problems, process engineering, inspection policies, and methods-organizing ability. Has proved record, finest references. Seeks executive or supervisory position in line with qualifications. Me-770.

POSITIONS AVAILABLE

TIME-STUDY MAN, 25–30, to develop and install production standards in plant. Progress, attitude, and ability in doing standards work will determine how and where man can be fitted into production organization. About $3000 year, but dependent upon qualifications of applicant. New England. W-860.

[1] All men listed hold some form of A.S.M.E. membership.

Any Special Knowledge of Foreign Countries?

THE United States Government is in need of specialized or unusual information from professional and scientific people of commodities used or produced abroad, and economic, industrial, and social conditions in foreign countries. If you do have such information based on your own experiences (not casual tourist data) copies of the proper government form will be sent to you upon request to the headquarters of the A.S.M.E., 29 West 39th St., New York, N. Y.

MAINTENANCE ENGINEER, preferably graduate mechanical, experienced in machine-tool installation and maintenance and general plant maintenance; would be in responsible charge of department in large manufacturing plant. $3600–$6000 year, depending upon past record, experience, etc. Permanent. Upstate New York. W-862.

SAFETY ENGINEER, either mechanical, electrical, civil, or chemical engineering graduate. $3600–$4200 a year. Mississippi. W-867.

ASSISTANT PERSONNEL DIRECTOR for large metal-manufacturing company. Company will consider good employment manager or supervisor of employee training so that these men might be released for personnel position. $4200–$4800 a year. Massachusetts. Interviews, New York, N. Y. W-871.

PLANT SUPERINTENDENT, under 45, married, with background of mechanical engineering and physics, but should lean as much toward practical as the theoretical. Should know everything from maintenance work to ability to figure optical problems, including manufacture and maintenance of glass molds, grinding tools, mechanical devices, etc. Must be able to instructively perform and supervise the work of 400 employees. Will manage and direct all manufacturing operations, and must have ability to interpret the specifications of customer into manufacturing practicality. Salary open. Also need younger man with less experience. Ohio. W-875-D.

MECHANICAL ENGINEER familiar with design and operation of power plant, refrigeration and kitchen equipment; competent to examine plans and specifications of mechanical equipment for large project and make up schedules of parts required for replacements and repairs. Apply by letter stating age, education, business experience, including names of former employers, etc. About $5200 a year. New England. W-878.

ENGINEER with considerable experience in design of centrifugal pumping equipment, both from standpoints of development and hydraulic efficiency and economical standardized structural design. Should have executive ability; also general knowledge of patent work sufficient to enable him to co-ordinate his efforts with patent attorneys. Permanent. Will lead to position of chief engineer for well-qualified man. $5000–$7000 year. Middle West. W-890-C.

ENGINEERS, graduate mechanical, industrial, or chemical, for work in motion study, production flow, and other surveys and investigations to improve methods, processes, and conditions, including supplanting of hand methods with automatic machinery, the writing of material specifications, the planning of work layouts, etc. Write letter of application giving complete information. New York State. W-891.

ASSISTANT PROFESSORS of mechanical engineering. (*a*) One to teach mechanics and related subjects. (*b*) The other to teach aerodynamics and related subjects and be in charge of new aeronautical-engineering laboratory. Prefer applicants who can start immediately. $3000 year with opportunity to increase this $500–$1200 or more by teaching defense classes in evening. South. W-900.

GRADUATE MECHANICAL ENGINEER, 30–37, to act as plant engineer in connection with erection of new and repair of existing equipment. Should be familiar with air conditioning, electroplating, chemical machinery, and general plant machinery. Splendid opportunity for future. Permanent. Maryland. W-907.

MECHANICAL ENGINEERS with recent experience in operation of machine tools, to go out and survey plants and convert into war-materials manufacturing. $4600 year. Headquarters, New York, N. Y. W-911.

MACHINE-SHOP SUPERINTENDENT for manufacturers of high-precision gears. Should be experienced in specification, installation, and operation of machine tools, and in planning work, personnel, etc. Salary open. New Jersey. W-913.

MECHANICAL ENGINEER, about 35, who has done industrial engineering or who has had extensive industrial-engineering experience in machine shops. Should be thoroughly grounded in shop practice and have full comprehension of industrial-engineering principles. Experience in actually running machine shop would be helpful. Salary open. South. W-937.

PRODUCTION ENGINEER, 35–45, experienced in tubular products, particularly as applied to cutting, welding, and bending of steel and iron pipes. This experience necessary. $6000–$8000 a year. Location, New Jersey. W-944.

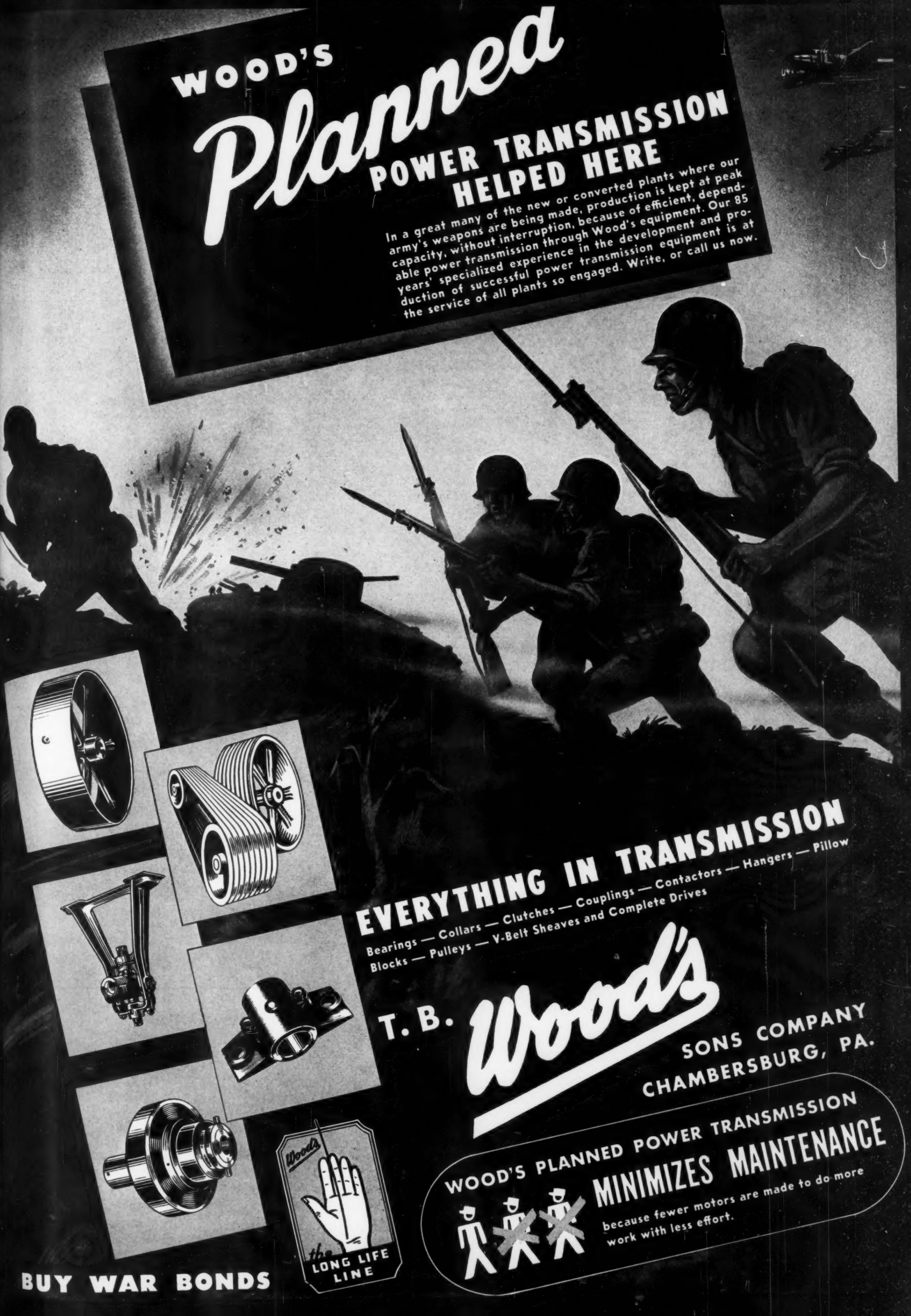
MECHANICAL ENGINEERS with sufficient experience in industry to make production capacity estimates of industrial plants. Should know progressive steps required in production of varied line of industries. Salary to $5600 a year. New York, N. Y. W-947.

CHIEF ENGINEERS for metalworking plant. Must be capable of directing small engineering organization in product development of small-tool manufacturing plant. Permanent. $7500 year. Locations: One for New England, the other for Middle West. Interviews, New York, N. Y. W-951.

INDUSTRIAL ENGINEERS who have had industrial-chemistry or mechanical-plant experience. Should have good training in time-study and production methods. Some

(*A.S.M.E. News continued on page 692*)

TUBE TURNS, INC., LOUISVILLE, KY. *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Tulsa, Houston, Los Angeles, Washington, D. C. *Distributors in all principal cities.*



A.S.M.E. Calendar
of Coming Meetings

Sept. 30–Oct. 1, 1942
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
St. Louis, Mo.

October 12–14, 1942
Fall Meeting
Rochester, N. Y.

Nov. 30–Dec. 4, 1942
Annual Meeting
New York, N. Y.

(*For coming meetings of other organizations see page 32 of the advertising section of this issue*)

packaging experience desired. Permanent. \$3200–\$3600 year. New York, N. Y. W-962.

TRAFFIC MANAGER to handle all traffic matters; also to take complete responsibility for all plant shipping and receiving departments as well as warehousing. \$5000–\$7500 year. New York metropolitan area. W-966.

MANAGEMENT AND PRODUCTION ENGINEERS to assist in converting nonessential plants to essential production operations. Should have manufacturing executive, planning, and scheduling experience. Considerable traveling. Salary, \$3800–\$5600 year. Headquarters, Washington, D. C. W-970.

ENGINEERING PROFESSORS with sufficient knowledge of French language to lecture in that language. Need men for electrical, mechanical, and other departments, who are qualified to help with program of teaching and research and, in some cases, take charge of department. Canada. W-990.

CHIEF ENGINEER OF DESIGN who will have complete charge, responsible only to the vice-president, of all engineering design for large heavy-machinery manufacturing company. Should, preferably, be experienced in large conveyer systems, scrapers, crushers, etc. \$10,000–\$12,000 year. Ohio. W-996.

SUPERINTENDENT, maintenance, for large mining property in United States. Department includes 150 maintenance men and includes machine shops, electrical equipment, construction, and townsite controlled by company. Salary open. South. W-997.

ENGINEERS for work in maintenance division. Prefer capable men with plant engineering experience in explosives or chemical industries, but can use men of this type who have had large plant experience in allied industries. Ohio. Interviews, Pennsylvania. W-1001-D.

EXECUTIVE ENGINEER, mechanical, thoroughly familiar with mechanical design, to co-ordinate work of designers and construction group on job, 2000 miles apart. Will also head group of expediters. \$6000–\$7500 year. Michigan. W-1029.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after September 25, 1942, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ARNOLD, DEWITT R., New York, N. Y.
BLOOMSTER, EDGAR L., San Francisco, Calif.
BOKUM, WM. H., New York, N. Y.
BONNELL, JOHN R., Chicago, Ill. (Rt & T)
BORNSTEIN, JOS., Brookline, Mass. (Rt)
BRECKENRIDGE, ROBT. W., Cleveland, Ohio
BRITTON, WM. M., Los Angeles, Calif. (Rt)
BROSNAN, W. J., Terre Haute, Ind.
COB, ALBERT W., Horseheads, N. Y.
DAVISON, CHAS. R., Erie, Pa.
ELO, LEO G., Bremerton, Wash.
EMMONS, GILBERT C., Oak Park, Ill.
FITZGERALD, J., Newport, R. I.
GALLOWAY, ALEX K., Baltimore, Md.
GANDELOT, HOWARD K., Grosse Pointe Woods, Mich.
GIPSON, ALLEN H., New York, N. Y. (Rt)
GREGORY, T. STANLEY, Scarsdale, N. Y.
GROSSWENDT, CARL, Bloomsbury, N. J. (Rt)
HIGHSTONE, HARRY M., Mar Vista, Calif.
HLAD, FRANK P., St. Louis, Mo.
HOLMSTROM, ANDREW BIRGER, Worcester, Mass.
IRVING, THOS. P., Lakewood, Ohio
JEFFREY, ROBT. K., Bexley, Ohio
JENKINS, F. G. (LIEUT.), Watertown, Mass.
JOHANNSEN, JOHN FREDK., Peoria, Ill.
KEELY, HAZAEL L., Pittsburgh, Pa.
KETLER, CHAS. P., Rockville Centre, N. Y.
KIMBALL, EDWIN E., Schenectady, N. Y.
LEPRE, JACK F. (LIEUT.), New York, N. Y.
McDONALD, RAYMOND N., Nashville, Tenn.
McMAHON, THOS. E., Upper Darby, Pa.
MILLER, MELVILLE S., Las Vegas, Nevada
MORGAN, RICHARD L. (CAPT.), Flushing, N. Y.
MUENCH, ERWIN J., Newark, N. J.
MUMMA, MILTON C., Charleston, W. Va.
NESBITT, JAS. W., St. Louis, Mo. (Rt)
PANKEY, THOS. L., Milwaukee, Wis.
PEALER, ROBT. B., Garretsville, Ohio
PLANIOL, ANDRE P. E., Huntington, N. Y.
POLLARD, ELLERY C., Salt Lake City, Utah
PUTRYAE, EDW. J., San Francisco, Cal. (Rt & T)
REILLY, C. TYSON, Pottsville, Pa.
ROBINSON, H. A., Providence, R. I. (Rt)
ST. JOHN, LEIGH E., Endicott, N. Y.
SCHOTT, RUDOLPH D., Pomona, Calif.
SHEEHAN, EDW. F., Philadelphia, Pa.
SILVER, FRANCIS, 5TH, Martinsburg, W. Va.
SIMON, WALTER R., West Allis, Wis.
SMITH, GEO. E., Hiwassee Dam, N. C.
SPENNER, FRED H., St. Louis, Mo. (Rt & T)
STEHMAN, FREDK. G., Riverdale, N. Y.
TAIT, GORDON EDW., Thorndale, Pa.
THOMAS, EMORY F., Nashville, Tenn.
URSCHEL, HAROLD C., Bowling Green, Ohio
VIERCK, JOHN C., Columbus, Ohio
WICKERSHAM, ROBT. O., State College, Pa.
WILSON, HAROLD M., Arlington, Mass.
WUNNER, GEO. W., Rutherford, N. J.

CHANGE OF GRADING

Transfers to Fellow

FRY, LAWFORD H., Pittsburgh, Pa.
MAXWELL, MAXWELL C., New York, N. Y.
SILLCOX, L. K., Watertown, N. Y.
TOWERS, JAS. F., New York, N. Y.

Transfers to Member

BATES, ARTHUR C., Bethlehem, Pa.
GARDINER, CECIL M., Schenectady, N. Y.
HOWARD, JAS. H., Houston, Tex.
LOVELAND, ROBERT P., Fort Wayne, Ind.
ROBINSON, CHAS. H., Alcoa, Tenn.
SALISBURY, J. KENNETH, Schenectady, N. Y.
STAPFER, R. D., Philadelphia, Pa.
WHITE, ELLIS E., Brooklyn, N. Y. (Rt)

Transfers from Student-member to Junior—102

A.S.M.E. Transactions for August, 1942

THE August, 1942, issue of the Transactions of the A.S.M.E. contains:

Hydraulic-Engineering Problems at Southwark Generating Station, S. L. Kerr and Stanley Moyer
Advanced Design—Original Features Embodied in New 160,000-Kw Oswego Steam Station, N. R. Gibson and H. M. Cushing
Energy Transfer Between a Fluid and a Rotor for Pump and Turbine Machinery, S. A. Moss, C. W. Smith, and W. R. Foote
Comparative Characteristics of Fixed- and Adjustable-Blade Axial-Flow Pumps, J. D. Scoville
Some Problems in the Selection and Operation of Centrifugal Pumps for Oil and Gasoline Pipe Lines, A. Hollander
Test Stand for Centrifugal and Propeller Pumps, G. F. Wislicenus

Necrology

THE deaths of the following members have recently been reported to headquarters:

ALLNER, FREDERICK A., July 18, 1942
BOYE, BURTON L., July 9, 1942
DOBLE, WILLIAM A., June 22, 1942
HAYS, JOHN C., July 21, 1942
McNAIRY, AMOS B., April 18, 1942
REIST, HENRY G., July 5, 1942
RUNGE, ROBERT F., July 6, 1942